NASA TECHNICAL MEMORANDUM

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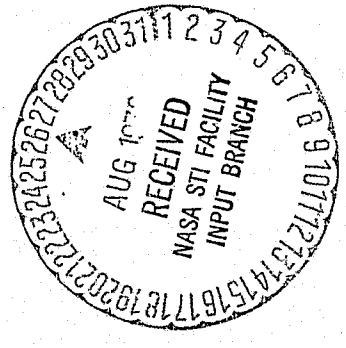
PACE

PRICING AND COST ESTIMATING HANDBOOK

Prepared by
Systems Analysis and Integration Laboratory
and Computer Services Office

July 1976



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16. ABSTRACT

In 1973, when the Marshall Space Flight Center began the practice of preparing independent government cost estimates on a regular basis to support Source Evaluation Boards, to evaluate changes, and to perform cost analyses, it was recognized at the outset that an automatic data processing system would be both desirable and necessary to compile estimates with large numbers of inputs. A concept of an automatic data processing system was envisioned where all computations needed to perform a cost estimate were done automatically rather than manually, and where cost data would be printed out in useable, organized, and readable output. This handbook describes the PACE (Pricing and Cost Estimating) system which has evolved over the past 4 years from this original concept and describes its purpose, makeup, use, and capabilities.

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PRICING AND COST ESTIMATING HANDBOOK

I. INTRODUCTION AND BACKGROUND

In early 1973 the Marshall Space Flight Center (MSFC) initiated an effort to develop and establish an automatic data processing system to be used primarily for the preparation of industrial engineering type manhour and material cost estimates. This computer system, termed PACE (Pricing and Cost Estimating), was established and has evolved over the past several years into a highly versatile and highly flexible tool which significantly reduces computation time, eliminates computational errors, and reduces typing and reproduction time for estimators and pricers. Since this system makes all mathematical and clerical functions automatic once basic inputs are derived, the time of estimators, estimate managers, secretarial personnel, and engineers involved in the estimating and cost analysis process can be devoted to collection, analysis, adjustment, and publication of ground rules, inputs, and rationale. This system also reduces the manhours required for manual computations and documentation.

Basic features of the PACE system are (1) A uniform method of depicting and numbering a Work Breakdown Structure (WBS), (2) a uniform labor rate structure, (3) a uniform format for input and output data, and (4) uniform methods in applying overhead, General and Administrative (G&A), fee, and escalation.

The PACE programs are written in the COBOL programming language to execute on a UNIVAC 1108 computer under the EXEC-8 operating system. The minimum hardware configuration required for running the PACE system is 1 Central Processor, 1 Card Reader, 1 Uniservo Tape Drive, 1 FASTRAND or Disk Mass Storage Unit, and 1 Line Printer.

This handbook has been prepared to facilitate use by those not familiar with the PACE system or with detailed automatic data processing techniques; therefore, an attempt has been made to be explanatory and specific in all areas where actions are required to implement and activate the system.

II. HISTORY

A. Initial System Development

The initial development of the PACE system began during the period of March through June 1973 in response to a request by the Government Cost Estimating Office of the MSFC Procurement Office, to the Computer Services Office. This request called for a computer program that would "provide a rapid computation response for pricing Government independent estimates, or repricing proposals, involving numerous WBS blocks over a period of several years."

The request also specifies a capacity of as many as seven levels of WBS with input to be furnished for each block (WBS element) in the cost components of manpower, material, travel, and other direct. Manpower figures were further broken down into categories such as engineering, manufacturing, tooling, quality and reliability assurance (Q&RA), testing, and other, with data to be accepted in units of manhours, manmonths, and manyears. Material, travel, and other direct information was to be in total dollars for each WBS element. In addition, labor rates were to be provided as input for each manpower category as well as percentage rates for calculating material burden, G& A expense, and fee/profit. All manpower, fixed cost, and rate figures were to be designated by year within a range of 1 to 9 years.

For each element defined at the lowest level of the WBS, the system was designed to calculate, summarize, and print a total estimated cost report consisting of labor, material, material burden, travel, other direct, and G& A costs for all years specified by the input. Summations of these values were then made and printed out for each successively higher WBS element until the highest level was reached. In addition to this, a manpower summary report which consisted of a mirror reflection of the basic input of labor and dollars which were to be used in calculating costs for each WBS element was also requested.

The initial system was designed for input via keytape with labor and fixed dollar raw data for each estimate stored on a master file which could be updated with new or revised values before the estimating calculations were done. Five programs were written for file maintenance, cost calculation, and printing; the first live production estimate was made in late June 1973.

B. Phase I Modification

After reviewing the results of the first production runs, it became apparent that certain deficiencies existed in the original design, and the PACE system entered an initial shakedown phase which lasted for approximately 3 months. During this time it was discovered that the cost estimators utilized varying factors for converting manpower figures from manhours to manyears. To provide for this, the PACE programs were modified to accept a variable conversion factor as input rather than using an assumed value of 2080 manhours per manyear.

The original design also called for labor rates to be specified in terms of dollars per manyear. This was expanded to provide for inputs in units of dollars per manhour and manmonth as well. In addition, the initial production runs had utilized rate tables which were entered as fresh input for each run. The system was modified to store several rate tables in the data base with provisions for subsequent updating. These tables could then be used repetitively rather than re-entering them for each run.

Another problem occurred during this period wherein the system required a dummy (zero) input for nonexistent WBS elements represented by gaps or breaks in the WBS numbering scheme. A modification was made to ignore this condition and not require redundant inputs.

During this modification phase, which lasted through September 1973, production estimates were run for the Solid Rocket Motor "Strawman", Space Shuttle External Tank, and Space Tug projects.

C. Phase II Modification

Over the following 2 months, several more estimates were made with the PACE system, including a final estimate on the Space Tug. These jobs gave rise to a number of format changes to improve the readability of the reports. During this time the fiscal year spread over which estimates could be developed was reduced from 9 to 8 years, and the printing of the manpower summary report was temporarily discontinued since it was generally not being used. At the end of November 1974, the PACE system entered a period of inactivity which lasted for approximately 9 months.

D. Phase III Modification

The PACE system was reactivated in September 1974 again under the sponsorship of the Cost Analysis Office of the newly organized Systems Analysis and Integration Laboratory at MSFC. Due to the proliferation of Source Evaluation Boards being organized to support the contract award process for the Space Shuttle and other important projects, it was requested that the PACE system be adapted to give pricing and cost estimating support while providing for the sensitivity of contract data utilized by the Source Evaluation Boards. Accordingly, a sensitive run procedure was developed wherein the Cost Analysis Office was given complete control over the preparation of input data, the setting up of run decks, the processing of production runs in a private machine room environment, and the reproduction and distribution of output reports. This procedure was designed to eliminate support contractor involvement in all but the keypunch and computer operation phases of the production cycle. As the practice developed, cost analysis personnel later absorbed the keypunch function as well.

To implement this procedure, several changes were made in the design of the PACE system. All inputs were changed from keytape to punched cards to improve user flexibility and control in preparing inputs and setting up production runs. This involved the consolidation of raw data for each WBS element into two 80-column cards. The security of contractor data after a production run was complete also became a matter of major concern. To overcome this, the practice of storing raw manpower and rate data on magnetic tape was abandoned and all production runs were designed to be made with fresh input from cards on a per job basis, with machine memory being cleared at the termination of each job. In this manner the Cost Analysis Office could exercise close control over data storage and minimize opportunities for unauthorized access. The sensitive run procedure became operational in November 1974.

Another useful change not related to data sensitivity was also made by providing an automatic internal zeroing of numeric data fields for which no input was submitted. This prevented machine errors which unduly tied up the computer during PACE-private processing.

E. Phase IV Modification

Beginning in March 1975, the PACE system entered a new phase of development aimed at increasing its capabilities and enhancing its flexibility. The two-card input for WBS element raw data was further optimized and reduced to a one-card input. A design-to-cost capability was programmed, giving the

user the ability to increase or decrease the basic manpower and dollar values in the base data by a given factor to achieve a specific total cost figure through a trial and error process. Modifications were made to the input methodology to enter recurring and nonrecurring costs for each WBS element, and to produce two additional cost estimate reports showing recurring and nonrecurring costs separately. An option was also provided for specifying a contractor fee percentage which could be applied to the total cost estimate to give a grand total cost at the highest level of the WBS. The latest option to be added was the capability of entering escalation factors which will increase the WBS base data for material, travel, and other direct dollars for the particular production run in which the escalation is specified. This most recent change became fully operational in December 1975.

During this most recent period of improvement, several production estimates were made on such projects as Solid Rocket Booster Structures, Environmental Science Package, Thrust Vector Control Actuators, Solid Rocket Booster Decelerator, and Solar Heating and Cooling Integration.

Although many other useful variations of PACE are possible, as described in Section VI, no further modifications are planned at this time. Current efforts are now being focused on system documentation, including this Handbook.

III. USES OF THE PACE COMPUTER SYSTEM

Although the PACE computer system has been used primarily for the preparation of industrial engineering type manhour and material cost estimates prepared by the Cost Analysis Office in the Systems Analysis and Integration Laboratory, a number of other applications are feasible and desirable to conserve resources required to prepare an estimate. Some of the existing and possible uses of the PACE system are described in the following paragraphs.

A. Major Projects

For major projects entering into the Phase C and D periods, the PACE system can be used to generate budgetary estimates based on resources inputs at the lowest WBS level. The PACE system can also be used for a comparative analysis of preliminary concepts where large numbers of alternatives are to be considered. Speed of computation and ease of comparison due to uniform format

make the PACE system attractive for this purpose. The principal use of the PACE system for major projects is in the source evaluation process, but it can also be used in tradeoff studies, change estimates, and budgetary studies. A "grounds-up" cost estimate using the PACE system can be used as a baseline for developing estimates of changes in major projects. These uses are described in more detail in the following paragraphs.

B. Experiments, Modules, and Subsystems

Because of flexibility in the WBS numbering system, the PACE system can be used for developing a "stand-alone" estimate of a part of a major program. Hence, estimates of experiments, modules, and subsystems can be made independent of the major program and combined at a later date.

C. Procurements

Although the PACE system has not been extensively used for procurement purposes to date, it is possible to use this method of collecting costs to build up a cost estimate prior to commitment to procurement services, hardware, and materials by using organizations. Use for this purpose would depend upon the desirability of spending the manhours and computer time required to develop an estimate.

D. Source Evaluation

The PACE computer system has found its greatest use in the preparation of independent government estimates to be used in Source Evaluation Board (SEB) evaluation proceedings. Some of the applications are (1) the government estimate and alternates, (2) adjustments to the government estimate, (3) verification of the mathematical accuracy of proposals, (4) pricing and manhour adjustments to proposals, (5) development of most probable costs, (6) adjustments resulting from written and oral discussions, and (7) adjustments based on best and final offers. The "adjusted government estimate" and "most probable cost" are often used for substantiation of the government's position in the event of a protest; therefore, the accuracy and speed provided by the PACE system are of utmost importance.

E. Other Possible Uses

The basic structure and methodology of the PACE system make it adaptable to the performance of sensitivity analyses (i.e., sensitivity to labor rate and skill mix variations), design-to-cost exercises, and economic analyses involving the time value of money. Due primarily to the lack of publicity or knowledge of the PACE system, however, it has not been used for these purposes extensively to date. However, it is anticipated that with the publication of this Handbook, these types of uses will increase.

IV. METHODOLOGY OF ESTIMATING

Use of the PACE computer system is based on the development of manhours and materials, travel, and other direct costs for the lowest level of each WBS being estimated. Therefore, application of the PACE system is appropriate primarily where sufficient definition exists to define design and configuration parameters of hardware, manloading and time-phasing of engineering and support type functions, and specific plans relative to location of the work, documentation required, and type of skill required. In a design-to-cost situation, a grounds-up estimate must be made first to develop a baseline. Then the design-to-cost factor is applied to spread the reduction or increase down to the lowest level. Fruitful use of this technique insists upon a detailed negotiation and rationalization of the manhours to the work to be performed; i.e., the schedule, hardware requirements, specifications, or design must be modified to adapt to the manhour and material constraints developed in the design-to-cost estimate. Methodology of estimating is more fully described in NASA Technical Memorandum TM X-64966. This technical memorandum shows how the basic estimate worksheets are derived through a process of ground rule development, information interchange, and estimate synthesis.

V. PACE COMPUTER SYSTEM

A. Automation of Basic Estimates

1. General. Figure 1 is an illustration of the general scheme of operation for the PACE system. The necessary inputs to the system, the computer program phases of data manipulation, and the various reports generated by the

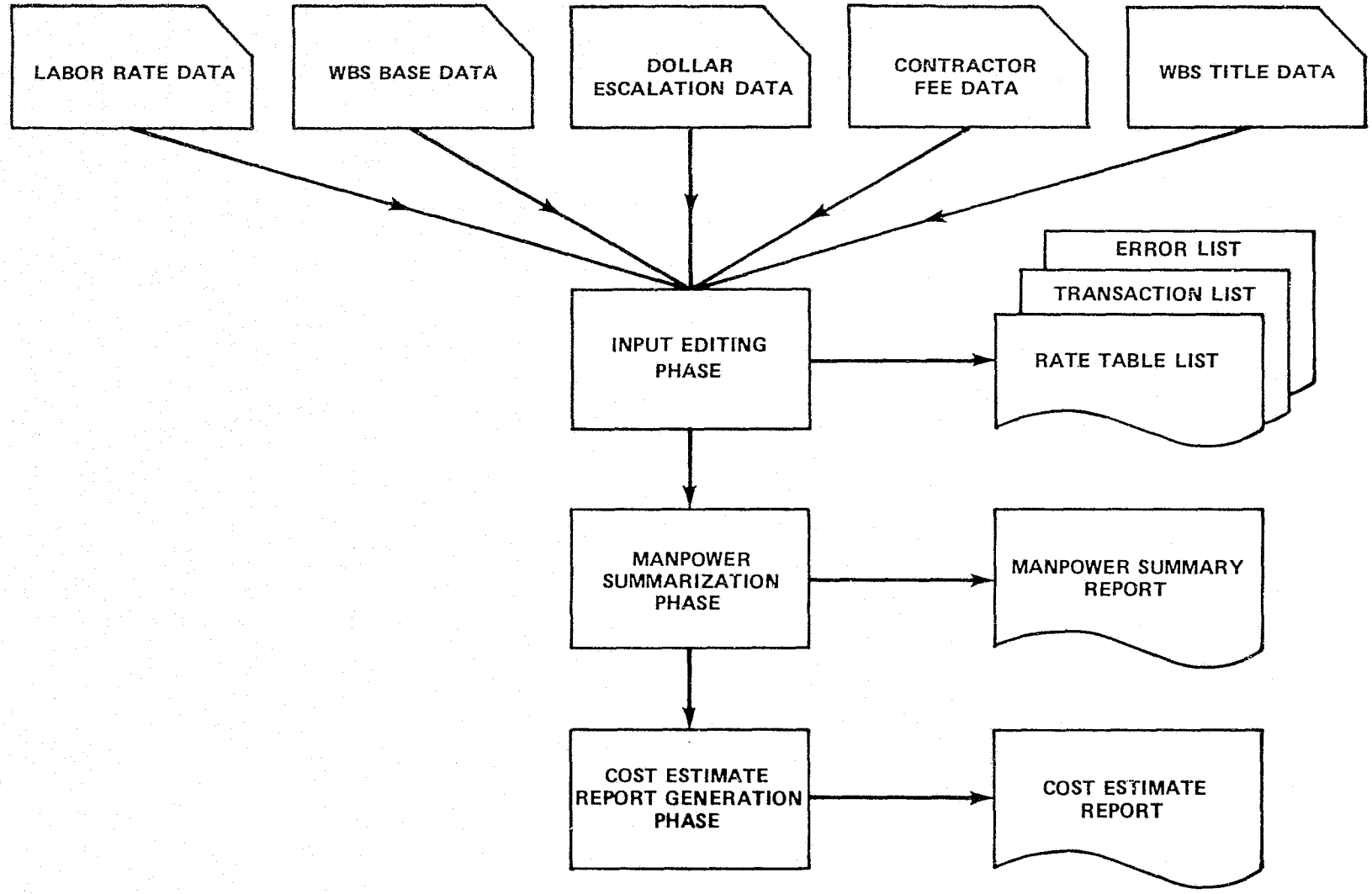

Figure 1. General schematic of PACE flow.

system in the course of a basic cost estimate computer run are shown in this figure. A more detailed description of the system's functions and capabilities will be given in the following paragraphs.

a. Input Types and Definitions — There are five basic types of user-supplied input to PACE, all of which are entered into the system on standard 80-column computer cards: (1) labor rate data, (2) WBS element manpower and dollar data, (3) WBS element dollar escalation data, (4) contractor fee data, and (5) WBS title data. For the purpose of simplicity, input types 2 and 3 will subsequently be referred to as WBS base data and dollar escalation data, respectively.

b. Labor Rate Data — This input type includes the fiscal year span for the cost estimate, the labor rates (given in dollars per manhour, manmonth, or manyear) per fiscal year for the given labor categories, G&A expense percentages per fiscal year, and materials burden (overhead) percentages per fiscal year.

c. WBS Base Data — Each card of this input type represents one element or "block" at the lowest extremities of the WBS for a particular fiscal year and contains the estimated amount of labor (in manhours, manmonths, or manyears) per labor category, and dollar expenses (material, travel, and other direct) for that fiscal year-WBS element combination.

d. Dollar Escalation Data — Data defined by this input type are projected dollar escalation rates per fiscal year for the span of the cost estimate. These rates apply only to the material, travel, and other direct dollar expenses given in the WBS base data.

e. Contractor Fee Data — Only one card is required for this input type. This card supplies the system with a percentage of the total estimated cost a contractor would charge for the completion of the project.

f. WBS Title Data — The cards for this input type supply descriptive titles to the corresponding WBS element codes used in the WBS base data cards. The WBS element code and corresponding title are displayed in the total cost estimate report.

g. System Data Manipulations — As the inputs flow through the logic of the system, they are channelled through numerous arithmetic calculation and data manipulation routines. These routines can be categorized into three basic phases: (1) input editing phase, (2) manpower summarization phase, and (3) cost estimate report generation phase.

h. Input Editing Phase — The editing phase is a critical function of the system because it ensures that the inputs conform to the specified requirements of the different input types. All inputs are edited thoroughly; however, the complexity of the editing routines vary from one input type to another.

i. Manpower Summarization Phase — The WBS base data cards that completed their editing routine successfully are passed on to the manpower summarization phase. Using the WBS element codes of these cards, this phase constructs the actual WBS to be detailed by the cost estimate report. The labor hours and the material, travel, and other direct dollar figures collected from the inputs to this phase are aggregated and stored for each element of the WBS.

j. Cost Estimate Report Generation Phase — The data structure produced by the manpower summarization phase and the labor rate cards, dollar escalation cards, contractor fee card, and WBS title cards comprise the inputs to the cost estimate report generation phase. The base data stored for each WBS element is used as a matrix for the application of the labor rates, dollar escalation rates, contractor fee and WBS title match-ups. After all computations have been made, the cost estimate report is formatted and printed on continuous forms showing the cost breakdown per fiscal year of the estimated project from the highest to the lowest levels of the WBS.

k. Outputs Developed — Figure 1 illustrates five reports generated in a basic cost estimate run. These five reports are: (1) rate table list, (2) transaction list, (3) error list, (4) manpower summary report, and (5) cost estimate report. All reports are printed on standard 11 × 14-7/8 inch continuous computer forms. Complete copies of each of these reports are included in Appendices A through E, and a detailed discussion of each report is contained in Section V.A.6, Output Descriptions.

2. Input Preparation. The following paragraphs describe the preparation of all inputs to PACE. These instructions and those in the following paragraphs on computer run setup, data editing, cost calculations, and output descriptions are further illustrated by means of a sample cost estimate. Figure 2 shows a diagram of the WBS for the project labeled ABC Project used in the example. The time span of the estimate covers fiscal years 1976 through 1979.

a. Labor Rate Data — The labor rate "table" consists of one header card, which gives the fiscal year span of the estimated project, one card for each of the six labor categories, one card for the G& A expense percentages, and one card for the materials burden percentages, for a total of nine cards. The formats for these cards are as follows:

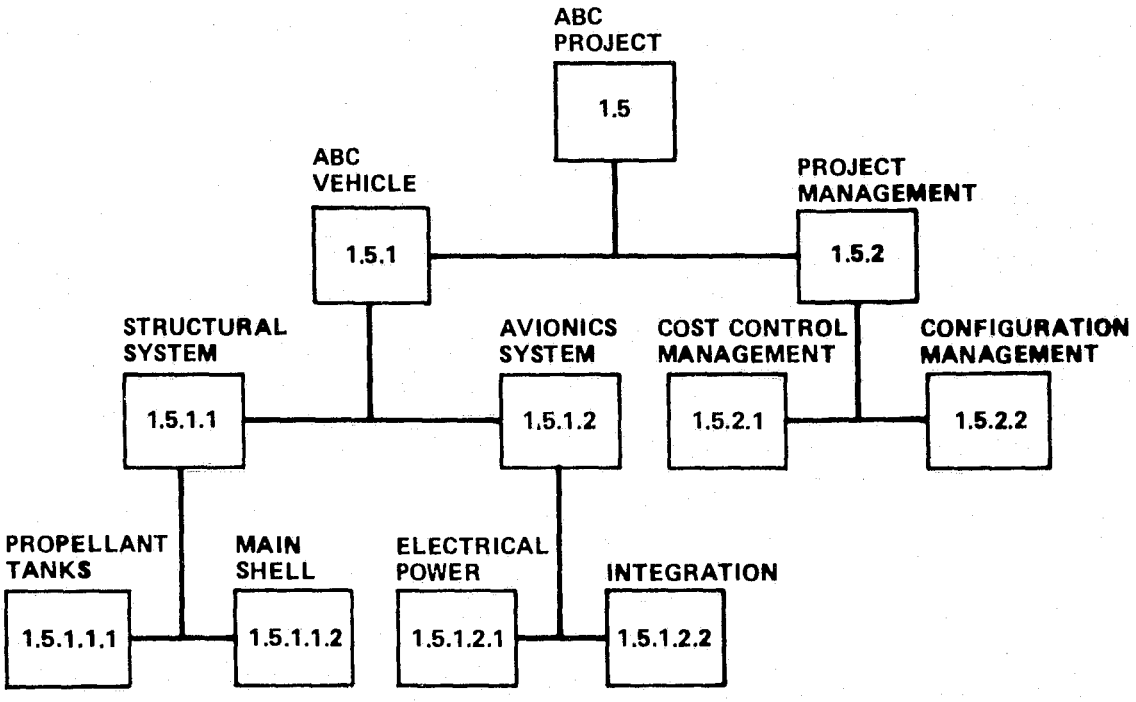

Figure 2. Sample WBS.

Header Card

Card Columns	Item	Content
1-2	N/A	Blanks .
3	Manpower code	Letter "H", "M", or "Y"
4	N/A	Blank
5-8	Year No. 1	Four digits, numeric (1976, etc.)
13-16	Year No. 2	Four digits, numeric
21-24	Year No. 3	Four digits, numeric
29-32	Year No. 4	Four digits, numeric
37-40	Year No. 5	Four digits, numeric
45-48	Year No. 6	Four digits, numeric
53-56	Year No. 7	Four digits, numeric
61-64	Year No. 8	Four digits, numeric
65-75	N/A	Blanks
76-78	Project code	Any character other than blank
79	Revision code	Any character other than blank
80	Transaction code	Letter "B"

The manpower code designates the labor rate entries furnished in the remaining cards of the table as being in dollars per manhour (H), manmonth (M), or manyear (Y). The project and revision codes are supplied at the option of the user to uniquely identify the estimate being made.

Labor Rates and Expense Percentage Cards

Card Columns	Item	Content
1-3	Activity code	"ENG" (engineering) "GA" (general and administrative expense percentage) "MAT" (materials burden percentage) "MFG" (manufacturing) "OTH" (other) "QRA" (quality and reliability assurance) "TLG" (tooling) "TST" (testing)
4-11	1st rate	Numeric rate with three decimal positions (99999.999)
12-19	2nd rate	Same as above
20-27	3rd rate	Same as above
28-35	4th rate	Same as above
36-43	5th rate	Same as above
44-51	6th rate	Same as above
52-59	7th rate	Same as above
60-67	8th rate	Same as above
68-75	N/A	Blanks
76-78	Project code	Any characters other than blanks
79	Revision code	Any characters other than blanks
80	Transaction code	Letter "B"

Appendix F shows the rate data used in the sample estimate as it is entered on the Computer Input and Worksheet (Rate Data). Note that the first card (header card) in the example specifies the rates in terms of dollars per manyear by use of the letter Y in column 3. All labor rates shown are in whole dollars with the symbol V indicating the decimal position. The percentages for General and Administrative (GA) and Materials Burden (MAT) expense are entered as 11 percent and 3 percent, respectively.

b. WBS Base Data = Labor hours and dollar values for materials, travel, and other direct expenses are accumulated on worksheets and summary forms as described in Appendix D of NASA TM X-64966. From these rough

forms, the data are then transcribed to MSFC Form 514, Computer Input and Worksheet (Base Data) which arranges the data in card format. A card is prepared for each fiscal year per WBS element at the lowest extremities of the WBS as follows:

Base Data Cards

Card Columns	Item	Content
1	Transaction code	Letter "B"
2	Manpower code	Letter "H", "M", or "Y"
3-4	Fiscal year	Two digits, numeric (76, 77, etc.)
5-20	WBS element number	Left justified, numeric, with zeros replacing decimal point figures.
21-27	Engineering	Right justified, numeric, whole numbers
28-34	Manufacturing	Same as above
35-40	Tooling	Same as above
41-46	Q& RA	Same as above
47-52	Testing	Same as above
53-58	Other	Same as above
59-66	Material dollars	Same as above
67-72	Travel dollars	Same as above
73-79	Other direct dollars	Same as above
80	Recurring and nonrecurring code	Letter "R" or "N"

The manpower codes designate the units in which the labor time is expressed, i.e., manhours (H), manmonths (M), or manyears (Y). Manpower codes can vary from one base data card to the next; however, all labor figures in each card must be consistent with the specified manpower code. Appendix G shows base data input for the sample estimate entered on Form 514. Although the recurring and nonrecurring code is shown in this example, it is not utilized in a basic estimate. A full discussion on recurring and nonrecurring cost options is given in Paragraph V. B. 3.

The base data cards must be preceded by two additional cards upon entry into the PACE system. These cards, known as header 1 and header 2 cards, are used for identification of the estimate and for internal control.

Base Data Header 1 Card

Card Columns	Item	Content
1-4	N/A	Blanks
5-8	Month conversion factor	Four numeric digits
9-12	Year conversion factor	Four numeric digits
13-79	N/A	Blanks
80	Header code	Letter "H"

The month and year conversion factors allow the estimator to control the number of manhours per month or manhours per year used in converting the labor specified by the manpower codes "M" and "Y", respectively, in the base data cards. The sample estimate used in this section utilizes a manhours per month figure of 163 and manhours per year as 1960.

Base Data Header 2 Card

Card Columns	Item	Content
1-2	N/A	Blanks
3-4	Control code	"**" (Asterisks)
5-20	Project name	Free form
21-80	N/A	Blanks

The project name is entered here for use as an overall title on the cost estimate reports.

c. WBS Title Cards — A separate set of input is required to identify the WBS elements in an estimate for the labeling of report pages. One card is required for each element title with format as follows:

WBS Title Cards

Card Columns	Item	Content
1-23	WBS element number	Free form as the number should appear on the cost estimate report
25-64	WBS element title	Same as above
65-80	WBS element number	Left justified, numeric, with zeros replacing decimal point figures.

Title card input for the sample estimate is shown in Appendix H.

d. Keypunching — All inputs developed for the PACE system should be recorded on the input forms described in the preceding paragraphs. Header cards and WBS title cards can be coded on standard 80-column general purpose forms or a suitable substitute. Data from these forms should then be keypunched, verified and assembled for production as described in the following paragraphs.

3. Computer Run Setup. After all PACE System input data have been generated as previously described in Input Preparation, it is then necessary to assemble a computer input run deck or, as it is more commonly referred to, a "run stream". A run stream is a composite deck of data cards in final format and assembly and ready to be read into the object computer's storage mediums via an attached card reader device. The run stream is made up of what is termed "control cards" and "data cards," or the user's input. The function of the run stream control cards is to direct the operations which are about to take place. Such tasks as the assignment of various input/output devices and the allocation of adequate internal data storage are communicated through control cards at precisely the time when the facilities are to be needed. Therefore, in a run stream for a system such as PACE where a number of unique user programs are to be set up and executed in a predetermined sequence and where user supplied card input is required at the execution of the individual programs, it becomes necessary to intersperse user data cards and computer control cards in a specific order.

A graphic representation of the PACE run stream is depicted in Figure 3. Also, a complete printout of the PACE run stream for the sample estimate is available for reference in Appendix I. Note that input cards for dollar escalation and contractor fee are also included in these examples, however, these cards contain no input necessary for a basic estimate and are required only for continuity of program flow. A complete treatment of the use of these special data cards can be found in Paragraphs 4 and 5 of this section.

4. Editing of User Input Data. In an effort to improve the reliability and validity of the user's input data before it becomes an integral part of permanent files, reports, etc., it is a policy of good automatic data processing practices to provide as many tests for accuracy as is possible early in the processing flow. This process is commonly referred to as editing.

The editing procedures executed within the PACE system are accomplished by the first phase of the execution flow. This phase includes the input editing functions as well as the sorting and sequencing of all valid input transactions for subsequent processing.

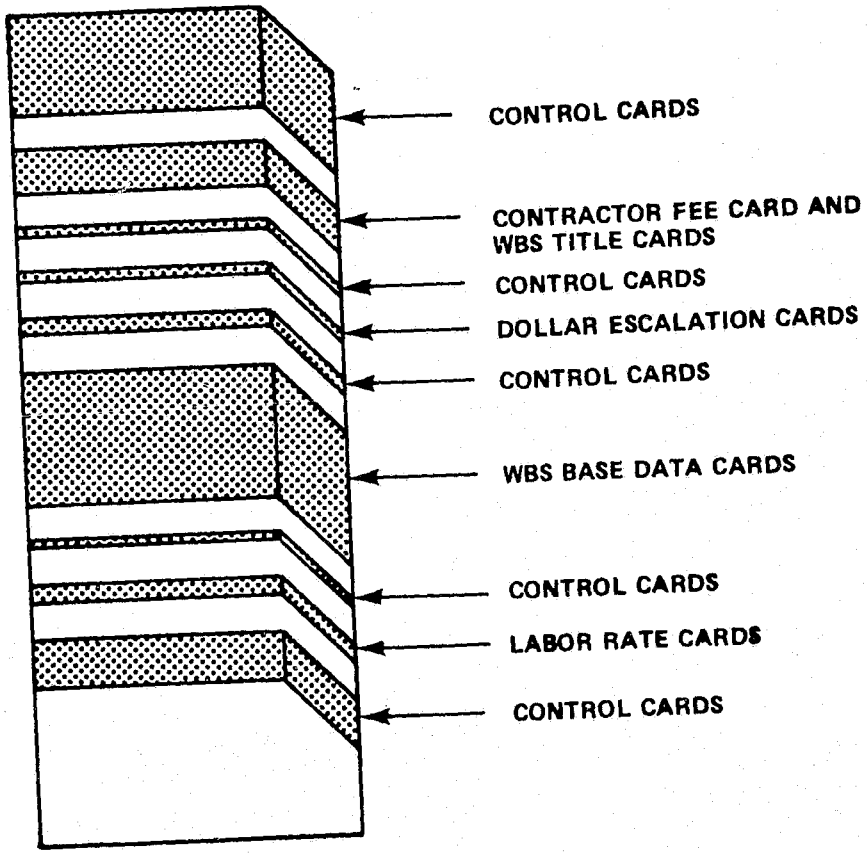

Figure 3. Run deck setup.

Whenever a data error is detected in an input card, an image of the card is printed on an error listing accompanied by an error code. The user can then review this error list and, by referring to a cross-reference list of error codes with error condition explanations and required corrective actions, the necessary data adjustments can be made and the input resubmitted on a following processing cycle. A sample edit error listing can be referenced in Appendix C, and a copy of the user's instructions for correcting data input errors is contained in Appendix J.

5. Cost Estimate Calculations. A number of calculation routines which are called upon in the course of preparing a cost estimate of a given WBS element for a single fiscal year are contained within the PACE system's programming logic. The following is a listing of the calculation steps involved in computing a given estimate:

a. Multiply the labor hours of each labor category by their respective composite rates (direct plus overhead costs).

b. Multiply the unescalated material (material is shown as material and subcon), travel, and other direct dollars by 1 plus their respective escalation rates, if any.

c. Multiply the material dollars by the materials burden percentage giving material overhead.

d. Add the total labor costs, material, material overhead, and the travel and other direct dollars giving the subtotal estimated cost.

e. Multiply the subtotal estimated cost by the G& A expense percentage for the appropriate fiscal year, giving the G& A expense.

f. Add the subtotal estimated cost and the G& A expense giving the total estimated cost.

g. Multiply the total estimated cost by the contractor fee percentage, if any, which is constant for all fiscal years, giving the fee amount.

h. Add the total estimated cost and the fee amount giving the grand total for the fiscal year.

6. Output Descriptions. The following paragraphs discuss in detail the content and purpose of each of the output reports which are generated by the PACE system.

a. Rate Table — The rate table is a formatted, one page listing of the labor rate input cards. The listing shows the fiscal year spread for the cost estimate, alphabetically lists the labor and expense categories with their respective dollar rates or expense percentages per fiscal year, and denotes the labor dollar rate entries as being in dollars per manhour, manmonth, or manyear. This report provides the user with a means of verifying the labor rates and expense percentages that have been entered in the labor rate data cards. A sample rate table is contained in Appendix A.

b. Transaction List — This report is an unformatted listing of all the WBS base data cards submitted for an estimate. Each line entry represents one WBS base data card, displaying the information exactly as it is punched in the card, with the exception that blanks appearing on the cards are printed as

zeros. The entries appear in order by fiscal year and WBS element codes. The transaction list will vary in the number of pages produced with the number of WBS base data cards submitted for a run. The purpose of the report is to provide the user with a printed image of all WBS base data input cards in ascending sequence by fiscal year and WBS element number. A sample transaction listing is contained in Appendix B.

c. Error List — The error list shows only the WBS base data input cards that did not pass the edit phase successfully. As in the transaction list, each entry of this report is an exact print image (zero filled) of the corresponding WBS base data card. For each entry, an error code will appear to the right denoting the information erroneously punched in the card. The length of this report will vary according to the number of invalid WBS base data cards.

Through reference to a list of corresponding error codes with accompanying instructions for making error corrections, the user is able to evaluate the problem and make the necessary corrective adjustments. A sample error listing can be referenced in Appendix C and an error code cross-reference is given in Appendix J.

d. Manpower Summary Report — The end result of the manpower summarization phase is a formatted report of the data structure produced by this phase. Each page of the manpower summary report represents one element of the WBS. Each WBS element code, with labor and direct dollar expenses summarized to its level in the WBS, is separated and labeled accordingly.

The first page of the manpower summary report displays the title of the project on which the estimate is being made and the succeeding pages contain the WBS element breakdown. The number of report pages is directly proportional to the number of elements contained in the WBS and the report is presented in the order of the WBS hierarchy.

The first line on each page shows the WBS element code with the totals of the labor hours and dollar expenses by category for all the fiscal year inputs to the particular WBS element. The entries that follow are fiscal year breakdowns of the totals reflected in the first entry.

Selected pages from the manpower summary report for the sample estimate are contained in Appendix D.

e. Cost Estimate Report — As previously stated, the data structure exhibited by the manpower summary report is given to the cost estimate report

generation phase for the application of the pertinent rates, percentages, and fees in arriving at a grand total cost estimate for a given project. The cost estimate report is presented in the same manner as the manpower summary report, each page representing one element of the WBS and the pages appearing in the order of the WBS hierarchy. Report headers on each page include identifying information such as the date of the estimate, the name of the project on which the estimate is being made, the WBS element code and corresponding title and, if selected, certain optional information which is pertinent to special report variations.

Within the basic cost estimate report is the capability of presenting labor and dollar estimates by category for up to eight fiscal year projections. Labor is always represented in units of manhours. Composite fiscal year totals are given for manhours and dollars for each category of cost, as well as totals for all categories of cost within each fiscal year. The report is presented in a matrix format with category of cost totals accumulated on the right vertical margin and fiscal year summations appearing on the lower horizontal print lines. The categories of cost are manufacturing, tooling, quality and reliability assurance, testing, other labor, materials, travel, other direct, and G& A expenses.

The first page of the report always indicates the highest element in the WBS hierarchy and therefore gives the total cost for the entire estimate. This page is also unique in that it has provision for including the effect of the contractor fee and dollar escalation options which are discussed more fully in Section V.

A copy of the cost estimate report for the sample estimate is given in Appendix E.

B. Cost Estimate Variations

1. General. In addition to calculating the basic cost estimates previously described, the PACE system contains the following options for modifying the results that are produced by a basic estimate. These options are:

a. Design-to-cost

b. Recurring and nonrecurring costs

c. Contractor fee

d. Direct dollar escalation.

Each of these options operate independently and may be used separately or in any combination with a basic estimate to achieve a desired effect. The following paragraphs describe the options in detail and give examples illustrating their use.

2. Design-to-Cost. The design-to-cost option is available for use in situations where a previously calculated cost estimate varies significantly from a design target cost and where it is desired to determine the impact of a change at all levels of the estimate so that the project technical and programmatic aspects can be altered to meet the cost target. If the need for a uniform redistribution of resources occurs, this can be achieved by including a design-to-cost factor as input in the PACE run deck. This factor, expressed as either a percent increase or decrease, will then be applied to the manpower and fixed dollar values in the base data for all WBS elements present. The resulting printouts will indicate the modified costs from the highest to the lowest level of the WBS, and the design-to-cost factor utilized will be shown on the total cost estimate report.

In using this feature, care must be taken to assure that manhour and material quantities resulting from the overall increase or decrease are reconciled with the schedule, hardware quantities, skill mix, specifications, and/or work elements of a revised (reduced or expanded) program or project. An arbitrary cut or increase unaccompanied by a corresponding change in the work to be performed can be dangerously misleading to estimators, work package managers, or management. Use of the design-to-cost feature must be accompanied by a renegotiation of resources versus specification, design, and/or hardware requirements down to the lowest level. If this renegotiation of resources estimates fails to yield a commitment to perform or a commitment to manage within these resources, the design-to-cost estimate must be voided in preference for either the original grounds-up estimate or an alternate estimate that can be restructured down to the lowest level to assure total project accomplishment within the target resource level. This stipulation, although it is a part of the project definition/engineering/cost estimating activity rather than the ADP data manipulation activity, must be remembered and adhered to so as to prevent the generation of unrealistic estimates.

a. Input Preparation — The design-to-cost factor should be entered in columns 15 through 17 of the first of the two WBS base data header cards. The system edits these data for numeric characters and assumes a decimal point between columns 15 and 16. An increase percentage may be specified by entering any number greater than 100 up to a maximum value of 999. With the assumed decimal, an entry of 105 would result in a 5 percent increase, 110 a 10 percent increase, etc. Likewise, an entry of 099 would represent a 1 percent decrease, 095 a 5 percent decrease, etc., with a lower input limit of 001.

b. Calculations — Upon execution, the PACE system will modify the values of the manpower figures and fixed dollar costs specified in the WBS base data by multiplying them by the design-to-cost factor. The remaining processing then continues identically to that of a basic estimate with the exception that the modified labor and dollar values will appear on the manpower summary and total cost estimate reports in place of the basic values. The data on the transaction list report, however, will be unaffected by this change. Revised manhour and material figures are then ready for return to and examination by individual estimators for development of impact statements, work scope, changes, schedule changes, or recombination or redivision of work elements resulting from the change in resources. It is reemphasized that this reconciliation process is mandatory to retain the credibility of the estimate.

c. Sample Reports — Selected pages from the manpower summary and total cost estimate reports for a run using the basic estimate example from Paragraph V. A. 2. and a design-to-cost factor of 092 are shown in Appendix K. Figure 4 illustrates the WBS base data header card used to make the design-to-cost entry (columns 15 through 17). This card is inserted in the run deck as shown in Appendix I. The net effect of this input is an 8 percent decrease in the resources available at each level.

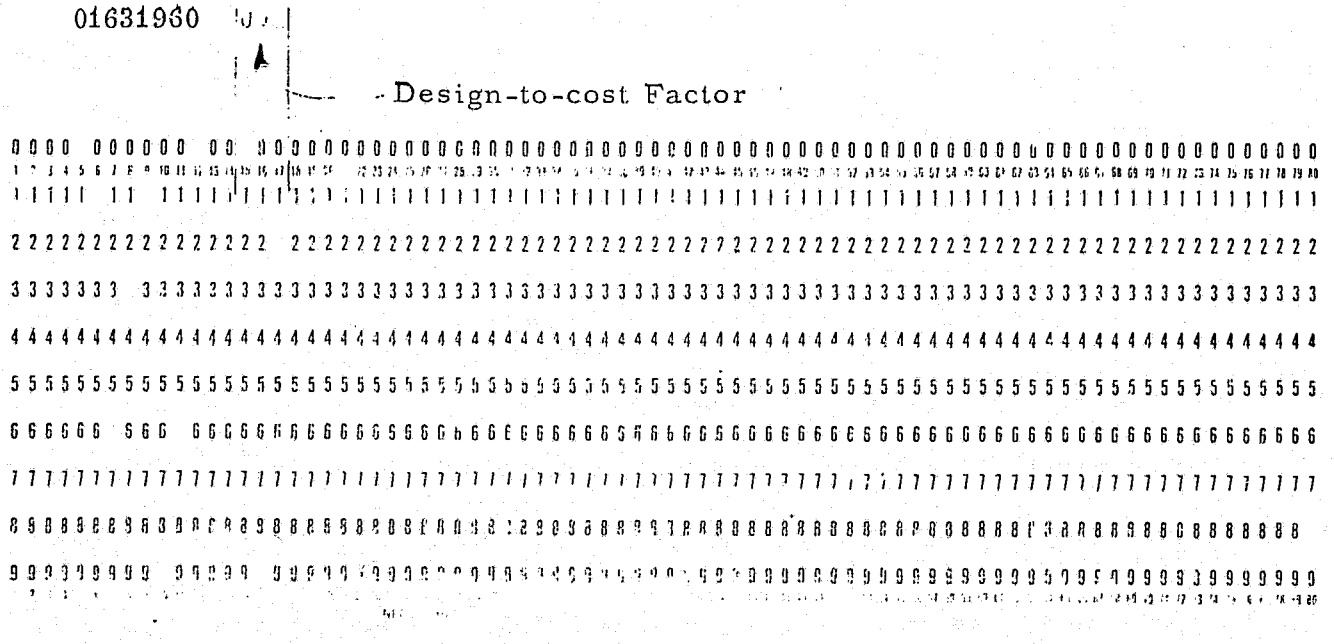

Figure 4. Design-to-cost factor.

Note that the title DESIGN-TO-COST FACTOR = 0.92 appears in the heading at the top of each page on each report. The same title is printed with the factor shown as 1.00 for reports not using this option.

3. Recurring and Nonrecurring Costs. Because of the need to separate recurring and nonrecurring costs within a total estimate to determine unit production costs as distinguished from design, development, testing, and engineering (DDT& E) costs, the PACE system contains an option for identifying WBS base data as either recurring or nonrecurring. Having done this, the user may then direct the computer to produce a cost estimate report showing only the recurring costs, and/or the nonrecurring costs, in addition to the normally generated total cost estimate report.

a. Input Preparation — The manpower figures and fixed dollar costs for each WBS element-fiscal year combination must be designated as recurring or nonrecurring by placing an R or an N, respectively, in column 80 of the WBS base data cards. An example of these can be found in the input for the sample case used in Paragraph A of this section. These identifiers must be present even in cases where no particular need exists for differentiating between the two. This coding will have no effect on the printing of the cost estimate reports, however, unless additional report control input is provided in the first of the two WBS base data header cards.

The numeral 1 appearing in column 19 of the header card will cause a cost estimate report to be produced showing only the recurring costs specified by the input. The title RECURRING COSTS ONLY will be printed at the top of each page. Similarly, the numeral 1 coded in column 20 of the card will produce a cost estimate report showing only the nonrecurring costs with the title NONRECURRING COSTS ONLY printed at the top of each page.

Either or both reports can be requested in this manner, and a blank in columns 19 or 20 will cause the system to ignore these report options. Any other character appearing in columns 19 or 20 will be interpreted as an error. The reports will be produced and printed in this manner in addition to the total cost estimate report which is an automatic consequence of each PACE production run.

b. Calculations — The totals of the recurring costs only version of the cost estimate report are derived by using only the cost element transactions marked R. The same is true for the nonrecurring costs only report and the transactions marked N. The total cost estimate report is a summation of the R and the N transactions regardless of whether either of the two optional reports are requested. The manpower summary report is unaffected by recurring and nonrecurring cost considerations.

c. Sample Reports — Selected pages of reports showing recurring and nonrecurring costs taken from a run using the basic estimate example from Paragraph V. A. 2 are shown in Appendix L. The first page is taken from the total cost estimate report and is labeled RECURRING AND NONRECURRING COSTS. The following two pages are taken from the recurring costs only and nonrecurring costs only reports.

Note that recurring costs have been specified for fiscal years 76, 78, and 79, while nonrecurring costs have been used for fiscal years 77, 78, and 79. This results in the two optional reports showing data only for the applicable years while the total cost estimate report indicates a summation of the two optional reports.

Figure 5 illustrates the WBS base data header card used to make the recurring and nonrecurring cost entries (columns 19 and 20). This card is inserted in the run deck as shown in Appendix I.

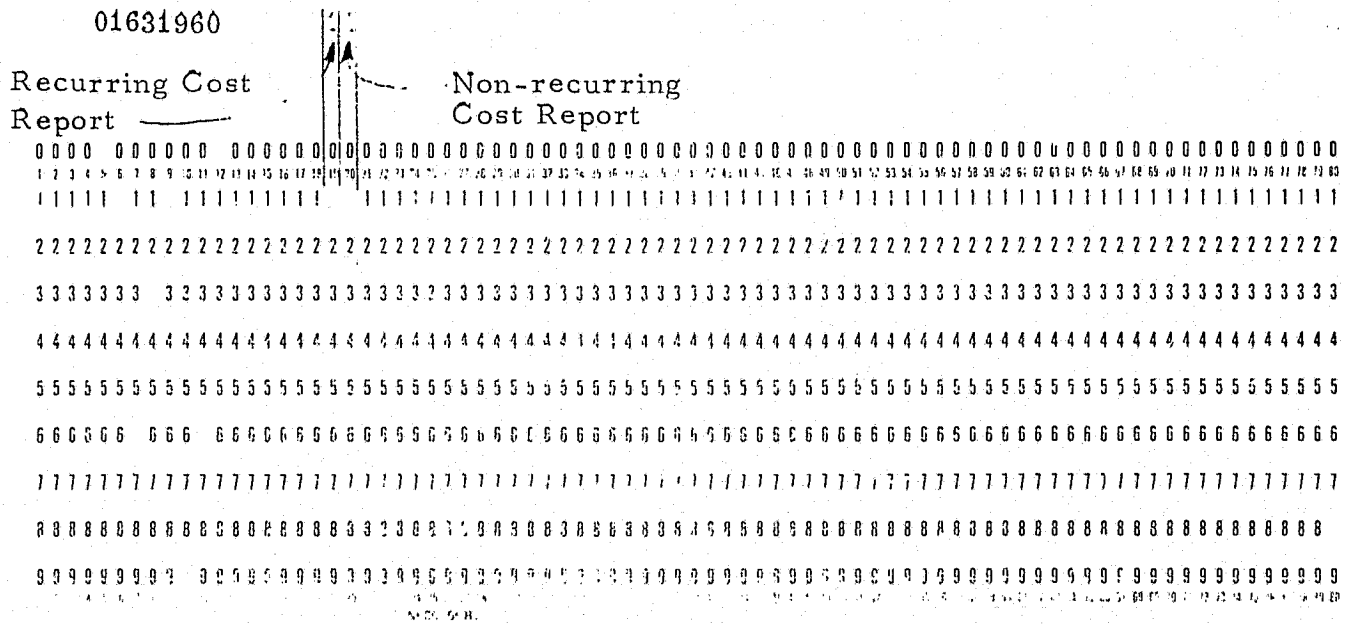

Figure 5. WBS base data header card.

4. Contractor Fee. Fees paid to government contractors can be included in a cost estimate by means of an optional input to the PACE system which specifies a percentage factor which is to be used in figuring the fee. The

fee amount is calculated at the highest level of the WBS and is printed out on the total cost estimate report together with a grand total for the entire estimate which includes the total estimated cost plus the fee.

a. Input Preparation — A contractor fee card is included as a mandatory input item in the run deck for each PACE production run. Columns 1 and 2 of the card are used to indicate the percent fee to be used. Fees may range in value from 01 to 99 representing whole number percentages (1 to 99 percent).

If a fee is not to be included in an estimate, the contractor fee card must still be furnished, however, with zeros in columns 1 and 2. Any other characters appearing in these columns, including blanks, will be treated as an error. The contractor fee card is inserted in the run deck as shown in Appendix I.

b. Calculations — After the final summation of total estimated cost is made, the contractor fee percentage is applied to the summary figures for each fiscal year and added to the total cost giving a grand total. The fee amounts and grand totals are then printed out as additional data on the total cost estimate page for the highest level WBS element. This is the only place where this information is shown. No other reports or report variations are affected by the contractor fee option.

c. Sample Report — A sample page of the total cost estimate report for the highest level WBS element in the basic estimate example using a contractor fee input of 8 percent is shown in Appendix M. Figure 6 illustrates the contractor fee card used to produce this option.

5. Direct Dollar Escalation. Material and subcontractor, travel, and other direct dollar values which have previously been utilized in a basic cost estimate on the PACE system can be modified for subsequent runs without disturbing the WBS base data cards used in the basic run. This feature has been provided to satisfy situations where it is desired to know the impact of increases to these costs over the time span of the estimate due to economic influences such as inflation. By means of escalation factors which are specified in the run deck, one or more PACE production runs can be made to show the effects of these variations while leaving the basic data intact.

a. Input Preparation — Three dollar escalation cards are required as mandatory input for each PACE production run. The coding MAT, TRV, and ODR is entered in columns 1 through 3 of the cards to indicate the categories of cost to be escalated. If no escalation is desired, as in a basic cost estimate, then no further input is necessary. If escalation is desired, however, the

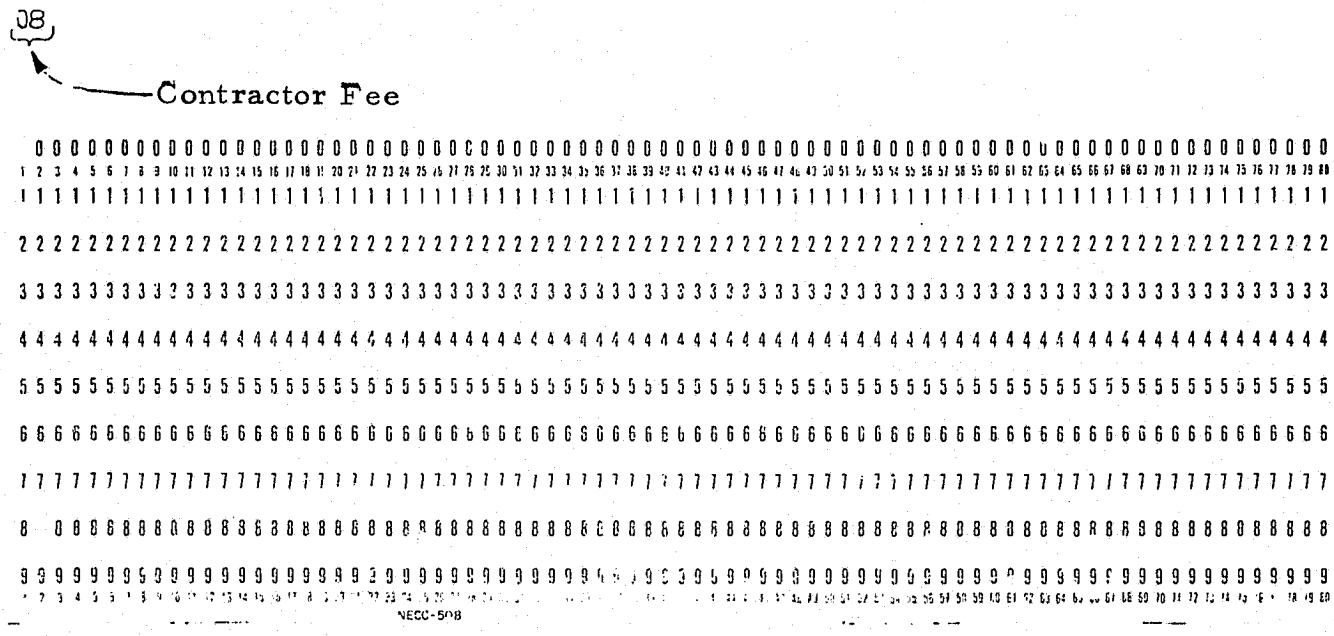

Figure 6. Contractor fee card.

factors to be used, expressed as percentage increases, are coded in the card immediately following the three-letter category identifier:

MAT = MATERIAL ESCALATION

TRV = TRAVEL COSTS ESCALATION

ODR = OTHER DIRECT ESCALATION

Three numeric characters must be furnished for each fiscal year value to be escalated with a decimal point assumed between the second and third character. Thus an entry of 025 would represent an increase of 2.5 percent. Any non-numeric input other than blanks will be interpreted as an error. The escalation factor for the fiscal year of the estimate should be entered in columns 4 through 6 of the appropriate category card; the factor for the second fiscal year in columns 7 through 9, etc. To be applied correctly, escalation factors must be consistent with the fiscal year entries present in the WBS base data. One exception to this is that, if the same escalation factor is to be used for all fiscal years within a cost category, it need only be specified once in card columns 4 through 6, leaving the remainder of the card blank. The system will automatically apply this factor in each year of the estimate.

Any or all of the three categories of cost can be escalated in the same PACE run. The direct dollar escalation cards are inserted in the run deck as shown in Appendix I.

b. Calculations — In preparing the total cost estimate report for escalation, the WBS base data for direct dollars are increased in the first fiscal year by the amounts specified by the first percentage factor entered in their respective escalation cards. The remaining fiscal years are increased by adding their escalation factors to the sum of all previous factors and multiplying the direct dollar value for that year by the accumulated factor. These increased values will be shown for each WBS element and on all versions of the total cost estimate report. The manpower summary report is not affected by the direct dollar escalation option.

c. Sample Reports — Selected pages from the total cost estimate report for a run using the previously mentioned basic estimate example and escalation input are shown in Appendix N. Figures 7 through 9 illustrate the direct dollar escalation cards used to produce this option. The material and subcontractor (MAT) and other direct (ODR) cards specify escalation factors for each of the fiscal years 76 through 79, and the travel (TRV) card specifies a constant factor to be used for each fiscal year.

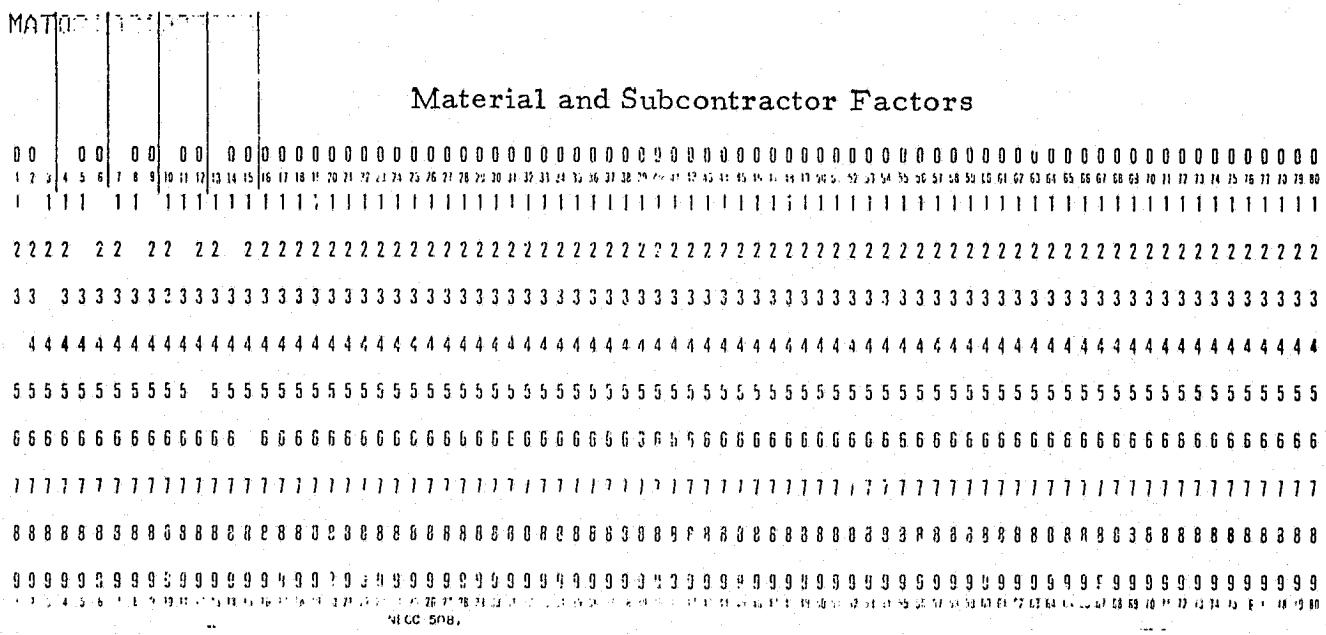

Figure 7. Material and subcontractor factors card.

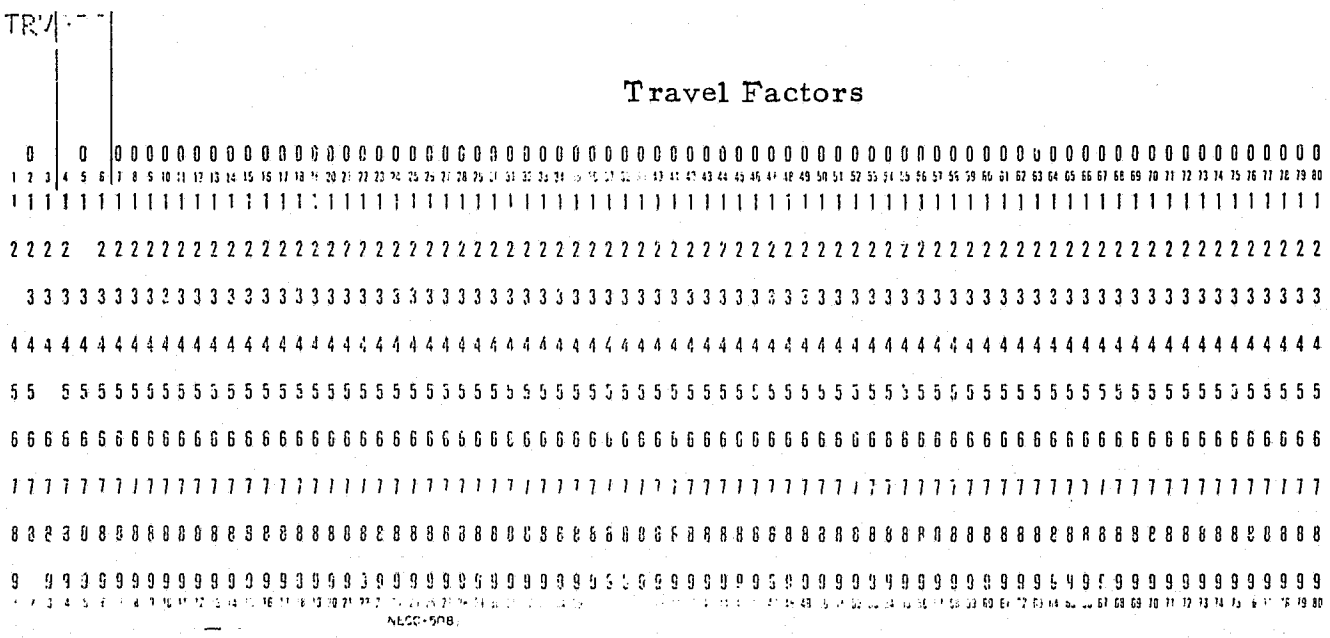

Figure 8. Travel factors card.

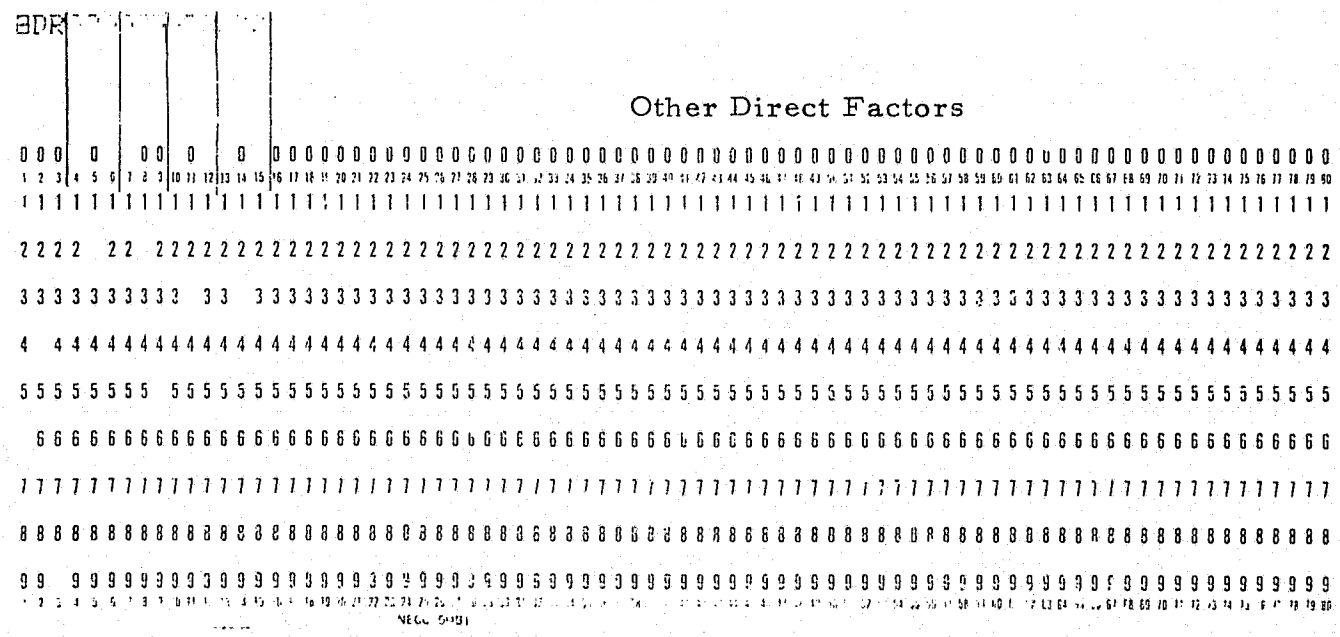

Figure 9. Other direct factors card.

Note that escalation factors from these cards (Figs. 7, 8, and 9) are printed out at the bottom of the page for the highest level WBS element. This is the only place in the total cost estimate report where this information will appear. The factors are printed out as zeros on reports not using the escalation option.

C. Processing of Sensitive Data

Since the PACE system was designed for use in support of NASA Source Evaluation Boards and other groups of government personnel who handle proprietary data developed by private contractors, a procedure is in effect at MSFC for eliminating the exposure of cost estimate data to nongovernment personnel so as to protect the confidentiality of the contracting relationship.

This procedure places the control of data preparation (keypunching) and run deck setup directly in the hands of the system user. The entire execution process from job submittal through collection of printed output products is performed under the direct observation of a government monitor. At the completion of each production run, the computer memory and all mass-storage hardware are cleared of data utilized or generated by PACE. The user then removes all run decks, printed reports, and other output products from the computer premises.

A copy of the current MSFC procedure for sensitive data processing is included as Appendix O.

VI. FUTURE IMPROVEMENTS AND POTENTIAL MODIFICATIONS

The PACE system, as presently configured, is a highly versatile and flexible tool that can be used for a wide variety of functions, as has been previously noted. Even so, one can envision a number of other applications for the system if modifications were made to the system, ranging from minor to significant. These potential uses are described in general in this Section. It is emphasized that detailed planning or estimating of programming effort to accomplish these modifications or changes have not yet been completed. At the present time, the following are only ideas for potential improvements.

A. Deescalation, Computation of Present Worth, Future Worth, or Annual Equivalent Costs of Alternate Proposals

Certain limited economic studies can be accomplished with the PACE system as now configured by applying various escalation rates to fixed dollar costs. Adaptation of this feature to accommodate deescalation of labor, materials cost, and other costs could facilitate the computation of present worth, future worth, or annual equivalent costs for use in economic analyses and comparison of alternate proposals. Thus, the "time value of money" could be taken into account in comparing two program funding alternatives. This feature would be particularly useful when the two alternatives vary considerably in distribution of funding requirements over the program time span. Comparisons on a present worth or annual equivalent basis are prevalent in industrial decisions where interest rates, discount factors, or rate-of-return comparisons are essential to choose the most economically attractive alternative.

B. Computation of Make/Buy and Skill Mix Ratios and Percentages

All of the basic data needed to compute labor/materials and/or make/buy ratios at each level of the WBS are available in a PACE estimate. These ratios are particularly meaningful when it is necessary to determine what proportion of the work in each area and in the total proposal or estimate is to be accomplished in-house and what portion is to be subcontracted. Sufficient data are also available in a PACE estimate to compute skill mix ratios at each level of the WBS. These ratios would indicate what proportion of the total labor hours is in the engineering category, what portion is manufacturing, etc.

C. Elimination of Intermediate Steps in Entering Raw Data on Cost Estimate Forms

The present cost estimating procedure includes the completion of cost estimating worksheets by the estimator, transcription of worksheet information onto computer keypunch forms, and keypunching from these latter forms. The first step could be eliminated if the computer keypunch forms could be modified to serve also as estimating worksheets. If this could be accomplished, the estimator could enter his numerical and written information directly onto the keypunch sheet, eliminating one step in the process.

D. Respreading of Costs

Real government estimating situations often encounter situations where (1) funding is limited for the first year or two years to a specified amount or (2) the maximum annual funding is specified or where the shape of the funding curve is specified in some other manner. Many industrial concerns have a standard set of funding spread curves which can be applied to any estimate and which will adjust the total and detailed costs to match the time-oriented expenditure of manhours or funds. The basic information required to accomplish this type of fund curve adjustment is available in a PACE-generated cost estimate.

E. Adaptation to a Universal Computer Program Language

Greater utilization of the PACE system would be achievable if it were adapted to a more widely used or universal computer language. Presently, the language used is adaptable to the compilation and computation techniques used at MSFC. Efforts now underway to convert PACE to the ASCII/ANSI version of the COBOL language will tend to minimize the amount of work required in adapting the system to any NASA computer facility. This standardization will enhance the attractiveness of the system by increasing its utilization potential.

F. Reduction of Time Increments Estimated

Perhaps the most extensive modification to the system envisioned would be the reduction of the timespan estimated for each element from the 1-year increment to a quarterly, monthly, or even weekly increment. Alteration of this time increment would involve sizable changes in the current estimating process as well as the computer system, but may be worthwhile at a later date due to various factors. First, requests for proposal are now requiring that the proposers subdivide costs into quarter-year increments. Verification of cost computations at this level of breakout by the PACE system would require reduction of the time increment estimated from yearly to quarterly. Secondly, a quarterly or monthly breakout would facilitate collection of fiscal year costs when different fiscal year bases are used (i.e., July 1 to June 30 versus October 1 to September 30 versus January 1 to December 31). Third, greater visibility of manpower and fund buildup over shorter increments in early years may be desirable because funding constraints during buildup are normally given close scrutiny to avoid too rapid an acquisition of a recurring funding requirement.

G. Cost Impact of Schedule Adjustments

Various PACE system modifications can be envisioned which would modify the fiscal year spread of manhours and resulting labor or material costs to account for differences in the scheduling of development, production, or operations support activities of a program. With the present cost breakout by fiscal year, costs for each WBS increment could be accelerated or decelerated in yearly increments. Further PACE system modifications to permit smaller time increments (semiannual, quarterly, or monthly) would permit finer adjustments in schedule-related costs. Differences in escalation costs brought about by these cost/schedule adjustments would be taken into account in the use of the appropriate escalated labor rate for each increment of time.

These and other modifications of the PACE system will be studied in the coming months to determine the economic and practical benefits of implementing them. Provided sufficient demand develops for the PACE system and its potential modifications, a time-phased program for system improvement will be instituted.

APPENDIX A

RATE TABLE REPORT

ABC-A IN MANYEARS RATE TABLE AS OF 26 APR 76

YEAR	1976	1977	1978	1979
ENG	22,771.000	25,344.000	26,611.000	27,936.000
GA	11.000	11.000	11.000	11.000
MAT	8.000	8.000	8.000	8.000
MFG	17,894.000	21,542.000	22,637.000	23,789.000
OTH	21,984.000	25,114.000	26,362.000	27,667.000
QRA	20,160.000	24,518.000	25,747.000	27,053.000
TLG	17,779.000	22,042.000	23,155.000	24,326.000
TST	20,314.000	22,176.000	23,290.000	24,442.000

APPENDIX B

TRANSACTION LIST

TRANSACTION LIST DATE 26 APR 76 PAGE 0001

BH7601050101010000000005000000900000750000200000120000000000500000060000005000R

BH7601050201000000000002500000200000000000400000000000500000065000075000000000R

BM7601050202000000000000150000006000000000005000000000040000000003000000000R

BH7701050101010000000005500000950000700000300000180000007500005000000600000800ON

BY7701050101020000000000030000005000004000002000003000000001000000000000275ON

BY7701050102010000000000003000000000003000001000001000001000180000000000000000N

BH7701050102020000000000800000075000050000050000015000000000000000000000000000N

BM7701050201000000000000012000001500000000002000000000020000000001000000000N

BM7701050202000000000000010000008000000000050000000000050000600000200000000N

BM7801050101010000000000030000002000002500002000001500000800008500000250000005000N

BM7801050101020000000000050000004000005000003000000800000000035000000750000000R

BY7801050102010000000000020000010000010000002000000000600000000000000000R

BH7801050102020000000000850000070000020000035000000000000000000000000000000R

BY7801050201000000000000001000000200000000000100000000000100000000000100000000R

BM7801050202000000000000012000001000000000007000000000006000000000020000000000N

BY7901050101010000000000005000000400000200000200000020000010000100000250000001750R

BM7901050101020000000000070000007000000000006000000000040001000000000000000600R

BY7901050102010000000000000000003000001000002000000000300006500000000000000000N

BM7901050102020000000000040000002000001000007000002500000000000000000000000000N

BY7901050201000000000000001000000200000000000100000000000100000000002000000000R

BH7901050202000000000003000000250000000000100000000000400000000000260000000000N

APPENDIX C

ERROR LIST

ERROR LIST DATE 05 MAY 76	ERROR MESSAGE
BY7H0I0502010000000000000000050000000500000000000000500000000000000000000000000N	INVALID FISCAL YEAR
ZH760I050101010000000000000013000000200000000000000000000000000000000000000000R	INVALID TRANSACTION TYPE
BH760I05010101000000000000015A000016500000000000000000000000000000000011000000R	TX COST ELEMENT NOT NUMERIC
BT780105010102000000000000000000000000000071000000000001000000000001000000000000N	INVALID MANPOWER RATE
BY780105020100000000000000100000013000120000100000000000000000000000000000520G	COLUMN 80 MUST CONTAIN R OR N
BH790I05020Y000000000000600000000000260000000006000000000000000000000000000000R	INVALID WBS

APPENDIX D

MANPOWER SUMMARY REPORT

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY	W B S	ENG	MFG	TLG	M+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
**ABC PROJECT										

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY	W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-S	TRAVEL-S	OTH DIR-S
01	05000000000000	79333	87450	49580	49999	28004	20097	385000	38750	23100
76	0105000000000000	9945	11978	7500	6815	1200	1152	56500	16500	5000
77	0105000000000000	28846	30549	25720	17955	11140	3851	178000	9000	10750
78	0105000000000000	18121	20382	8850	12310	7669	4242	126000	6250	5000
79	0105000000000000	22421	24541	7510	12919	7995	10852	26500	7000	2350

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY	W B S	ENG	MFG	TLG	W+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
	0105010000000000	61926	68753	49580	35048	28004	12506	370500	17750	23100
	7601050100000000000	5000	9000	7500	2000	1200		50000	6000	5000
	7701050100000000000	25260	26800	25720	13880	11140	2710	168000	6000	10750
	7801050100000000000	14205	14832	8850	9209	7669	1304	126000	3250	5000
	7901050100000000000	17461	18121	7510	9959	7995	8492	26500	2500	2350

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY	W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
01	05010100000000	33026	41193	31150	17567	16549	4666	340000	17750	28400
76	01050101000000000	5000	9000	7500	2000	1200		50000	6000	5000
77	01050101000000000	11380	19300	14840	6920	7680	750	150000	6000	10750
78	01050101000000000	5705	3912	4890	3749	3749	1304	120000	3250	5000
79	01050101000000000	10941	8981	3920	4898	3920	2612	20000	2500	2350

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY	W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
01	05010101000000	25190	29400	22495	12180	9365	4014	195000	17000	19750
76	01050101010000000	5000	9000	7500	2000	1200		50000	6000	5000
77	01050101010000000	5500	9500	7000	3000	1800	750	50000	6000	8000
78	01050101010000000	4890	3260	4075	3260	2445	1304	85000	2500	5000
79	01050101010000000	9800	7840	3920	3920	3920	1960	10000	2500	1750

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY	W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
01	05010102000000	7836	11593	8[illegible]	5387	7184	652	145000	750	3350
77	01050101020000000	5880	9800	7840	3920	5880		100000		2750
78	01050101020000000	815	652	815	489	1304		35000	750	
79	01050101020000000	1141	1141		978		652	10000		600

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY	W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
	0105010200000000	28900	27560	18430	17481	11455	7840	30500		
77	0105010200000000	13880	7500	10880	6960	3460	1960	18000		
78	0105010200000000	8500	10920	3960	5460	3920		6000		
79	0105010200000000	6520	9140	3590	5061	4075	5880	6500		

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
0105010201000000	5880	9800	9800	7840	5880	7840	30500		
7701050102010000000	5880		5880	1960	1960	1960	18000		
7801050102010000000		3920	1960	1960	3920		6000		
7901050102010000000		5880	1960	3920		5880	6500		

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY	W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
	0105010202000000	23020	17760	8630	9641	5575				
77	G105010202000000	8000	7500	5000	5000	1500				
78	0105010202000000	8500	7000	2000	3500					
79	0105010202000000	6520	3260	1630	1141	4075				

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY	W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
	0105020000000000	17407	18497		14951		7591	14500	21000	
76	0105020000000000	4945	2978		4815		1152	6500	10500	
77	0105020000000000	3586	3749		4075		1141	8000	3000	
78	0105020000000000	3916	5550		3101		2938		3000	
79	0105020000000000	4960	6420		2960		2360		4500	

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
0105020100000000	8376	12285		11180		4746	6500	11500	
7601050201000000000	2500	2000		4000		500	6500	7500	
7701050201000000000	1956	2445		3260		326		1000	
7801050201000000000	1960	3920		1960		1960		1000	
7901050201000000000	1960	3920		1960		1960		2000	

DATE 26 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 1.00

FY	W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
	0105020200000000	9031	6412		3771		2845	8000	9500	
76	0105020200000000	2445	978		815		652		3000	
77	0105020200000000	1630	1304		815		815	8000	2000	
78	0105020200000000	1956	1630		1141		978		2000	
79	0105020200000000	3000	2500		1000		400		2500	

APPENDIX E

COST ESTIMATE REPORT

DATE 04 MAY 76 | PROJECT-ABC PROJECT | DESIGN-TO-COST FACTOR = 1.00

WBS 1.5 | TITLE-ABC PROJECT | RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	9,945	28,846	18,121	22,421					79,333
	LABOR/OH $	115,531	372,979	246,029	319,567					1,054,106
MFG	HOURS	11,978	30,549	20,382	24,541					87,450
	LABOR/OH $	109,347	335,734	235,392	297,854					978,327
TOOLING	HOURS	7,500	25,720	8,850	7,510					49,580
	LABOR/OH $	68,025	289,221	104,545	93,207					554,998
Q. & RA	HOURS	6,815	17,955	12,310	12,919					49,999
	LABOR/OH $	70,092	224,599	161,704	178,308					634,703
TEST	HOURS	1,200	11,140	7,669	7,995					28,004
	LABOR/OH $	12,437	126,038	91,123	99,698					329,296
OTHER	HOURS	1,152	3,851	4,242	10,852					20,097
	LABOR/OH $	12,909	49,343	57,055	153,176					272,483
TOT LBR	HOURS	38,590	118,061	71,574	86,238					314,463
	LABOR/OH $	388,341	1,397,914	895,848	1,141,810					3,823,913
MATERIAL & SUBCON.		56,500	176,000	126,000	26,500					385,000
MATERIAL OVERHEAD		4,520	14,080	10,080	2,120					30,800
TRAVEL		16,500	9,000	6,250	7,000					38,750
OTHER		5,000	10,750	5,000	2,350					23,100
SUBTOTAL EST. COST		470,861	1,607,744	1,043,178	1,179,780					4,301,563
G. & A. EXPENSE		51,795	176,852	114,750	129,776					473,173
TOTAL EST. COST		522,656	1,784,596	1,157,928	1,309,556					4,774,736
FEE										
GRAND TOTAL		522,656	1,784,596	1,157,928	1,309,556					4,774,736

ESCALATION RATES

MATERIAL & SUBCON.	.000	.000	.000	.000
TRAVEL	.000	.000	.000	.000
OTHER	.000	.000	.000	.000

DATE 04 MAY 76 PROJECT-ABC PROJECT DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.1 TITLE-ABC VEHICLE RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	5,000	25,260	14,205	17,461					61,926
	LABOR/OH $	58,085	326,612	192,861	248,872					826,430
MFG	HOURS	9,000	26,800	14,832	18,121					68,753
	LABOR/OH $	82,161	294,532	171,295	219,935					767,923
TOOLING	HOURS	7,500	25,720	8,850	7,510					49,580
	LABOR/OH $	68,025	289,221	104,545	93,207					554,998
Q + RA	HOURS	2,000	13,880	9,209	9,959					35,048
	LABOR/OH $	20,570	173,625	120,969	137,454					452,618
TEST	HOURS	1,200	11,140	7,669	7,995					28,004
	LABOR/OH $	12,437	126,038	91,123	99,698					329,296
OTHER	HOURS		2,710	1,304	8,492					12,506
	LABOR/OH $		34,723	17,539	119,865					172,127
TOT LBR	HOURS	24,700	105,510	56,069	69,538					255,817
	LABOR/OH $	241,278	1,244,751	698,332	919,031					3,103,392
MATERIAL + SUBCON.		50,000	168,000	126,000	26,500					370,500
MATERIAL OVERHEAD		4,000	13,440	10,080	2,120					29,640
TRAVEL		6,000	6,000	3,250	2,500					17,750
OTHER		5,000	10,750	5,000	2,350					23,100
SUBTOTAL EST. COST		306,278	1,442,941	842,662	952,501					3,544,382
G + A EXPENSE		33,691	158,724	92,693	104,775					389,883
TOTAL EST. COST		339,969	1,601,665	935,355	1,057,276					3,934,265

DATE 04 MAY 76 | PROJECT-ABC PROJECT | DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.1.1 | TITLE-STRUCTURAL SYSTEM | RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	5,000	11,380	5,705	10,941					33,026
	LABOR/OH $	58,085	147,143	77,457	155,942					438,627
MFG	HOURS	9,000	19,300	3,912	8,981					41,193
	LABOR/OH $	82,161	212,107	45,180	109,002					448,450
TOOLING	HOURS	7,500	14,840	4,890	3,920					31,150
	LABOR/OH $	68,025	166,876	57,766	48,651					341,318
Q + RA	HOURS	2,000	6,920	3,749	4,898					17,567
	LABOR/OH $	20,570	86,562	49,247	67,602					223,981
TEST	HOURS	1,200	7,680	3,749	3,920					16,549
	LABOR/OH $	12,437	86,892	44,546	48,882					192,757
OTHER	HOURS		750	1,304	2,612					4,666
	LABOR/OH $		9,610	17,539	36,868					64,017
TOT LBR	HOURS	24,700	60,870	23,309	35,272					144,151
	LABOR/OH $	241,278	709,190	291,735	466,947					1,709,150
MATERIAL + SUBCON.		50,000	150,000	120,000	20,000					340,000
MATERIAL OVERHEAD		4,000	12,000	9,600	1,600					27,200
TRAVEL		6,000	6,000	3,250	2,500					17,750
OTHER		5,000	10,750	5,000	2,350					23,100
SUBTOTAL EST. COST		306,278	887,940	429,585	493,397					2,117,200
G + A EXPENSE		33,691	97,673	47,254	54,274					232,892
TOTAL EST. COST		339,969	985,613	476,839	547,671					2,350,092

DATE 04 MAY 76 | PROJECT-ABC PROJECT | DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.1.1.1 | TITLE-PROPELLANT TANKS | RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	5,000	5,500	4,890	9,800					25,190
	LABOR/OH $	58,085	71,115	66,392	139,679					335,271
MFG	HOURS	9,000	9,500	3,260	7,840					29,600
	LABOR/OH $	82,161	104,405	37,650	95,154					319,370
TOOLING	HOURS	7,500	7,000	4,075	3,920					22,495
	LABOR/OH $	68,025	78,715	48,138	48,651					243,529
Q + RA	HOURS	2,000	3,000	3,260	3,920					12,180
	LABOR/OH $	20,570	37,527	42,823	54,104					155,024
TEST	HOURS	1,200	1,800	2,445	3,920					9,365
	LABOR/OH $	12,437	20,365	29,051	48,882					110,735
OTHER	HOURS		750	1,304	1,960					4,014
	LABOR/OH $		9,610	17,539	27,665					54,814
TOT LBR	HOURS	24,700	27,550	19,234	31,360					102,844
	LABOR/OH $	241,278	321,737	241,593	414,135					1,218,743
MATERIAL + SUBCON.		50,000	50,000	85,000	10,000					195,000
MATERIAL OVERHEAD		4,000	4,000	6,800	800					15,600
TRAVEL		6,000	6,000	2,500	2,500					17,000
OTHER		5,000	8,000	5,000	1,750					19,750
SUBTOTAL EST. COST		306,278	389,737	340,893	429,185					1,466,093
G + A EXPENSE		33,691	42,871	37,498	47,210					161,270
TOTAL EST. COST		339,969	432,608	378,391	476,395					1,627,363

DATE 04 MAY 76 | PROJECT-ABC PROJECT | DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.1.1.2 | TITLE-MAIN SHELL | RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	5,880	815	1,141						7,836
	LABOR/OH $	76,028	11,065	16,263						103,356
MFG.	HOURS	9,800	652	1,141						11,593
	LABOR/OH $	107,702	7,530	13,848						129,080
TOOLING	HOURS	7,840	815							8,655
	LABOR/OH $	88,161	9,628							97,789
Q + RA	HOURS	3,920	489	978						5,387
	LABOR/OH $	49,035	6,424	13,498						68,957
TEST	HOURS	5,880	1,304							7,184
	LABOR/OH $	66,526	15,494							82,020
OTHER	HOURS			652						652
	LABOR/OH $			9,203						9,203
TOT LBR	HOURS	33,320	4,075	3,912						41,307
	LABOR/OH $	387,452	50,141	52,812						490,405
MATERIAL + SUBCON.		100,000	35,000	10,000						145,000
MATERIAL OVERHEAD		8,000	2,800	800						11,600
TRAVEL			750							750
OTHER		2,750		600						3,350
SUBTOTAL EST. COST		498,202	88,691	64,212						651,105
G + A EXPENSE		54,802	9,756	7,063						71,621
TOTAL EST. COST		553,004	98,447	71,275						722,726

DATE 04 MAY 76 | PROJECT-ABC PROJECT | DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.1.2 | TITLE-AVIONICS SYSTEM | RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	13,880	8,500	6,520						28,900
	LABOR/OH $	179,468	115,405	92,930						387,803
MFG	HOURS	7,500	10,920	9,140						27,560
	LABOR/OH $	82,425	126,115	110,932						319,472
TOOLING	HOURS	10,880	3,960	3,590						18,430
	LABOR/OH $	122,346	46,779	44,555						213,680
Q + RA	HOURS	6,960	5,460	5,061						17,481
	LABOR/OH $	87,063	71,723	69,852						228,638
TEST	HOURS	3,460	3,920	4,075						11,455
	LABOR/OH $	39,146	46,577	50,815						136,538
OTHER	HOURS	1,960		5,880						7,840
	LABOR/OH $	25,113		82,996						108,109
TOT LBR	HOURS	44,640	32,760	34,266						111,666
	LABOR/OH $	535,561	406,599	452,080						1,394,240
MATERIAL + SUBCON.		18,000	6,000	6,500						30,500
MATERIAL OVERHEAD		1,440	480	520						2,440
TRAVEL										
OTHER										
SUBTOTAL EST. COST		555,001	413,079	459,100						1,427,180
G + A EXPENSE		61,050	45,439	50,501						156,990
TOTAL EST. COST		616,051	458,518	509,601						1,584,170

DATE 04 MAY 76 | PROJECT=ABC PROJECT | DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.1.2.1 | TITLE=ELECTRICAL-POWER | RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	5,880								5,880
	LABOR/OH $	76,028								76,028
MFG	HOURS		3,920	5,880						9,800
	LABOR/OH $		45,272	71,366						116,638
TOOLING	HOURS	5,880	1,960	1,960						9,800
	LABOR/OH $	66,121	23,153	24,326						113,600
Q + RA	HOURS	1,960	1,960	3,920						7,840
	LABOR/OH $	24,518	25,747	54,104						104,369
TEST	HOURS	1,960	3,920							5,880
	LABOR/OH $	22,175	46,577							68,752
OTHER	HOURS	1,960		5,880						7,840
	LABOR/OH $	25,113		82,996						108,109
TOT LBR	HOURS	17,640	11,760	17,640						47,040
	LABOR/OH $	213,955	140,749	232,792						587,496
MATERIAL + SUBCON.		18,000	6,000	6,500						30,500
MATERIAL OVERHEAD		1,440	980	520						2,440
TRAVEL										
OTHER										
SUBTOTAL EST. COST		233,395	147,229	239,812						620,436
G + A EXPENSE		25,673	16,195	26,379						68,247
TOTAL EST. COST		259,068	163,424	266,191						688,683

DATE 04 MAY 76 PROJECT=ABC PROJECT DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.1.2.2 TITLE=INTEGRATION RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	8,000	8,500	6,520						23,020
	LABOR/OH $	103,440	115,405	92,930						311,775
MFG	HOURS	7,500	7,000	3,260						17,760
	LABOR/OH $	82,425	80,843	39,567						202,835
TOOLING	HOURS	5,000	2,000	1,630						8,630
	LABOR/OH $	56,225	23,626	20,230						100,081
Q + RA	HOURS	5,000	3,500	1,141						9,641
	LABOR/OH $	62,545	45,976	15,748						124,269
TEST	HOURS	1,500		4,075						5,575
	LABOR/OH $	16,971		50,815						67,786
OTHER	HOURS									
	LABOR/OH $									
TOT LBR	HOURS	27,000	21,000	16,626						64,626
	LABOR/OH $	321,606	265,850	219,290						806,746
MATERIAL + SUBCON.										
MATERIAL OVERHEAD										
TRAVEL										
OTHER										
SUBTOTAL EST. COST		321,606	265,850	219,290						806,746
G + A EXPENSE		35,377	29,244	24,122						88,743
TOTAL EST. COST		356,983	295,094	243,412						895,489

DATE 04 MAY 76 PROJECT=ABC PROJECT DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.2 TITLE=PROJECT MANAGEMENT RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	4,945	3,586	3,918	4,960					17,407
	LABOR/OH $	57,446	46,367	53,168	70,695					227,676
MFG	HOURS	2,978	3,749	5,550	6,420					18,697
	LABOR/OH $	27,186	41,202	64,097	77,920					210,405
TOOLING	HOURS									
	LABOR/OH $									
Q + RA	HOURS	4,815	4,075	3,101	2,960					14,951
	LABOR/OH $	49,522	50,974	40,735	40,854					182,085
TEST	HOURS									
	LABOR/OH $									
OTHER	HOURS	1,152	1,141	2,938	2,360					7,591
	LABOR/OH $	12,909	14,620	39,516	33,311					100,356
TOT LBR	HOURS	13,890	12,551	15,505	16,700					58,646
	LABOR/OH $	147,063	153,163	197,516	222,780					720,522
MATERIAL + SUBCON.		6,500	8,000							14,500
MATERIAL OVERHEAD		520	640							1,160
TRAVEL		10,500	3,000	3,000	4,500					21,000
OTHER										
SUBTOTAL EST. COST		164,583	164,803	200,516	227,280					757,182
G + A EXPENSE		18,104	18,128	22,057	25,001					83,290
TOTAL EST. COST		182,687	182,931	222,573	252,281					840,472

DATE 04 MAY 76 PROJECT-ABC PROJECT DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.2.1 TITLE-COST CONTROL MANAGEMENT RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	2,500	1,956	1,960	1,960					8,376
	LABOR/OH $	29,043	25,291	26,611	27,936					108,881
MFG	HOURS	2,000	2,445	3,920	3,920					12,285
	LABOR/OH $	18,258	26,871	45,272	47,577					137,978
TOOLING	HOURS									
	LABOR/OH $									
Q + RA	HOURS	4,000	3,260	1,960	1,960					11,180
	LABOR/OH $	41,140	40,779	25,747	27,052					134,718
TEST	HOURS									
	LABOR/OH $									
OTHER	HOURS	500	326	1,960	1,960					4,746
	LABOR/OH $	5,603	4,177	26,362	27,665					63,807
TOT LBR	HOURS	9,000	7,987	9,800	9,800					36,587
	LABOR/OH $	94,044	97,118	123,992	130,230					445,384
MATERIAL + SUBCON.		6,500								6,500
MATERIAL OVERHEAD		520								520
TRAVEL		7,500	1,000	1,000	2,000					11,500
OTHER										
SUBTOTAL EST. COST		108,564	98,118	124,992	132,230					463,904
G + A EXPENSE		11,942	10,793	13,749	14,545					51,029
TOTAL EST. COST		120,506	108,911	138,741	146,775					514,933

DATE 04 MAY 76 PROJECT-ABC PROJECT DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.2.2 TITLE-CONFIGURATION MANAGEMENT RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	2,445	1,630	1,956	3,000					9,031
	LABOR/OH $	28,404	21,076	26,557	42,759					118,796
MFG	HOURS	978	1,304	1,630	2,500					6,412
	LABOR/OH $	8,928	14,331	18,825	30,343					72,427
TOOLING	HOURS									
	LABOR/OH $									
Q. + RA.	HOURS	815	815	1,141	1,000					3,771
	LABOR/OH $	8,382	10,195	14,988	13,802					47,367
TEST	HOURS									
	LABOR/OH $									
OTHER	HOURS	652	815	978	400					2,845
	LABOR/OH $	7,306	10,443	13,154	5,646					36,549
TOT LBR	HOURS	4,890	4,564	5,705	6,900					22,059
	LABOR/OH $	53,020	56,045	73,524	92,550					275,139
MATERIAL + SUBCON.			8,000							8,000
MATERIAL OVERHEAD			640							640
TRAVEL		3,000	2,000	2,000	2,500					9,500
OTHER										
SUBTOTAL EST. COST		56,020	66,685	75,524	95,050					293,279
G + A EXPENSE		6,162	7,335	8,308	10,456					32,261
TOTAL EST. COST		62,182	74,020	83,832	105,506					325,540

APPENDIX F

RATE DATA INPUT

ABC Project
PROJECT NAME

DATE

COMPUTER INPUT AND WORKSHEET (Rate Data)

PREPARED BY

PACE SYSTEM (PRICING AND COST ESTIMATING)

PAGE OF

Activity	YR#1 RATE	YR#2 RATE	YR#3 RATE	YR#4 RATE	YR#5 RATE	YR#6 RATE	YR#7 RATE	YR#8 RATE	Proj ID	REV
Y	1976	1977	1978	1979					ABCAB	
ENG	22771	25344	26611	27936					ABCAB	
GA	11	11	11	11					ABCAB	
MAT	8	8	8	8					ABCAB	
MFG	17894	21542	22637	23789					ABCAB	
OTH	21964	25114	26362	27667					ABCAB	
QRA	20160	24518	25747	27053					ABCAB	
TLG	17779	22042	23155	24326					ABCAB	
TST	20314	22176	23290	24442					ABCAB	

APPENDIX G

BASE DATA INPUT

WBS NUMBER:

WBS TITLE:

COMPUTER INPUT AND WORKSHEET (Base Data)
PACE SYSTEM (Pricing And Cost Estimating)

DATE:

PAGE 1 OF 1

PROJECT NAME: ABC Project

PREPARED BY:

T.C. (1)	M.C. (2)	FY	WORK BREAKDOWN STRUCTURE CODE	MANPOWER: ENGINEERING	MANPOWER: MANUFACTURING	MANPOWER: TOOLING	MANPOWER: QUAL. & REL. ASSURANCE	MANPOWER: TESTING	MANPOWER: OTHER (3)	DOLLARS: MATERIAL $	DOLLARS: TRAVEL $	DOLLARS: OTHER DIRECT $ (4)	(5)
1	2	3–4	5–20	21–27	28–34	35–40	41–46	47–52	53–58	59–66	67–72	73–79	80
B	H	7[illegible]	0101010101	5000	7[illegible]	7500	2000	1200		50000	6000	5500	[illegible]
[illegible]	H	77	0101010102	[illegible]	9[illegible]00	70[illegible]	3000	1[illegible]	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	7[illegible]	[illegible]010101	30	[illegible]0	25	[illegible]	15	[illegible]	8[illegible]000	[illegible]	[illegible]	[illegible]
B	Y	77	0105010101		4	[illegible]	2	2	1	1[illegible]	[illegible]	175[illegible]	[illegible]
[illegible]	Y	77	01[illegible]5012102	3	5	[illegible]	2	3		100000		275[illegible]	[illegible]
[illegible]	[illegible]	[illegible]3	01[illegible]5[illegible]10102	5	4	5	3	8		35000	750		[illegible]
B	[illegible]	71	[illegible]1050101[illegible]2	7	7		6		4	10000		[illegible]	[illegible]
B	Y	77	01050102[illegible]1	3		3	1	1	1	18000			[illegible]
B	Y	7[illegible]	[illegible]105010201		2	1	1	2		6000			[illegible]
B	Y	[illegible]	0105010201		3	1	2		3	6500			[illegible]
B	H	77	0105010202	8000	7500	5000	5000	1500					[illegible]
B	H	7[illegible]	0105010203	8500	7000	2000	3500						[illegible]
[illegible]	[illegible]	7[illegible]	[illegible]105010[illegible]0[illegible]	40	[illegible]	10	7	[illegible]5					[illegible]
B	H	[illegible]	0105[illegible]01	2500	2000		4000		500	65000	7500		[illegible]
B	M	[illegible]	0105[illegible]01	12	15		20		2		1000		[illegible]
B	Y	75	0105[illegible]01	1	2		1		1		1000		[illegible]
[illegible]	Y	7[illegible]	01050201	1	2		1		1		2000		K
B	H	76	01050202	15	6		5		4		3000		[illegible]
B	H	77	0105[illegible]0[illegible]	10	8		5		5	8000	2000		[illegible]
B	H	7[illegible]	015[illegible]0[illegible]	12	10		7		6		2000		[illegible]
[illegible]	H	71	01056202	3000	75[illegible]		1000		400		2500		[illegible]

LEGEND:

(1) TC = Transaction Code: B = Build, C = Change, D = Delete

(2) MC = Manpower Code: H = Manhour, M = Months, Y = Manyears

(3) OTHER: Mgmt., Transp. Eqpt., Support, Training, Logistics, Facility Planning

(4) OTHER DIRECT: Computer Chg. Engr. Supplies and Materials

(5) R = Recurring, N = Non-Recurring

MSFC - Form 514 (April 1976)

APPENDIX H

TITLE CARD INPUT

WBS Title Card Worksheet

WBS Element Code (Print)	WBS Element Title	WBS Element Code (Numeric)
1.5	ABC PROJECT	0105
1.5.1	ABC VEHICLE	010501
1.5.1.1	STRUCTURAL SYSTEM	01050101
1.5.1.1.1	PROPELLANT TANKS	0105010101
1.5.1.1.2	MAIN SHELL	0105010102
1.5.1.2	AVIONICS SYSTEM	01050102
1.5.1.2.1	ELECTRICAL POWER	0105010201
1.5.1.2.2	INTEGRATION	0105010202
1.5.2	PROJECT MANAGEMENT	010502
1.5.2.1	COST CONTROL MANAGEMENT	01050201
1.5.2.2	CONFIGURATION MANAGEMENT	01050202

APPENDIX I

SAMPLE RUN DECK

```
@RUN      MRPACE,THNTSVA2060A,FTYSONBIN312,3,200
@RUN      MRPACE,1HNTSVA2060A,FTYSONBIN312,3,200
@ASG,T          PUR,T,17397 . BACKUP 27861
@DELETE,C       PACE1B
@DELETE,C       PACE1C
@DELETE,C       PACE1D
@DELETE,C       PACE1E
@DELETE,C       PACE1F
@DELETE,C       PACE1G
@DELETE,C       PACE2A
@DELETE,C       PACE2B
@DELETE,C       PACE2C
@DELETE,C       PACE3A
@DELETE,C       PACE3B
@DELETE,C       PACE3C
@DELETE,C       PACE3D
@DELETE,C       PACE4A
@DELETE,C       PACE4B
@DELETE,C       PACE4C
@DELETE,C       PACE5A
@DELETE,C       PACE6B
@DELETE,C       PACE7A
@DELETE,C       PACE7B
@DELETE,C       PACE7C
@ASG,T          PACE1B,F2/1/POS/2
@ASG,U          PACE1C,F2/13/TRK/13
@ASG,U          PACE1D,F2/1/POS/2
@ASG,U          PACE1E,F2/1/POS/2
@ASG,U          PACE1F,F2/1/POS/2
@ASG,U          PACE1G,F2/1/POS/2
@ASG,U          PACE2A,F2/13/TRK/13
@ASG,U          PACE2B,F2/13/TRK/13
@ASG,U          PACE2C,F2/13/TRK/13
@ASG,U          PACE3A,F2/1/POS/2
@ASG,U          PACE3B,F2/13/TRK/13
@ASG,U          PACE3C,F2/13/TRK/13
@ASG,U          PACE3D,F2/13/TRK/13
@ASG,U          PACE4A,F2/1/POS/2
@ASG,U          PACE4B,F2/1/POS/2
@ASG,U          PACE4C,F2/1/POS/2
@ASG,U          PACE5A,F2/1/POS/2
@ASG,U          PACE6B,F2/1/POS/2
@ASG,U          PACE7A,F2/1/POS/2
@ASG,U          PACE7B,F2/1/POS/2
@ASG,U          PACE7C,F2/1/POS/2
@ASG,T          X8,F2/83/TRK/03
@REWIND     PUR
@ERS
@COPIN          PUR.,TPF$.
@FREE       PUR
@PRT,T
@XQT        A2060C
   Y 1976    1977    1978    1979     ABCAB
ENG22771   25344   26611   27936     ABCAB
OA     11      11      11      11     ABCAB
MAT     8       8       8       8     ABCAB
MFG17894   21542   22637   23789     ABCAB
OTH21964   25114   26362   27667     ABCAB
QRA20160   24518   25747   27053     ABCAB
TLG17779   22042   23155   24326     ABCAB
TST20314   22176   23290   24442     ABCAB
```

Labor Rate Cards & Header Card

```
@PMD.EL
@XQT        A20608
    01631960                                                                   H
  **ABC PROJECT
BH760105010101     5000   9000   7500   2000   1200          50000   6000  5000R
BH770105010101     5500   9500   7000   3000   1800    750   50000   6000  8000N
BH790105010101       30     20     25     20     15      8   85000   2500  5000N
BY790105010101        5      4      2      2      2      1   10000   2500  1750R
BY770105010102        3      5      4      2      3          100000         2750N
BH780105010102        5      4      5      3      8           35000    750      R
BH790105010102        7      7             6             4   10000          600R
BY770105010201        3             3      1      1      1   18000              N
BY780105010201               2      1      1      2           6000              R
BY790105010201               3      1      2             3    6500              N
BH770105010202     8000   7500   5000   5000   1500                             N
BH790105010202     8500   7000   2000   3500                                    R
BH790105010202       40     20     10      7     25                             N
BH7601050201       2500   2000          4000           500    6500   7500       R
BH7701050201         12     15            20             2           1000       N
BY7901050201          1      2             1             1           1000       R
BY7901050201          1      2             1             1           2000       R
BH7601050202         15      6             5             4           3000       R
BH7701050202         10      8             5             5    8000   2000       N
BH7901050202         12     10             7             6           2000       N
BH7901050202       3000   2500          1000           400           2500       N
@PMD.EL
@FREE             PACE1C
@FRCE             PACE1E
@SYM         PACE1C
@SYM         PACE1E
@XQT         A2060C
@PMD.EL
@XQT         A2060C
@PMD.EL
@FREE             PACE3A
@SYM         PACE3A
@XQT         A2060E
MAT
TRV
ODR
@PMD.EL
@XQT         A2060F
00
1.5                    ABC PROJECT                    0105
1.5.1                  ABC VEHICLE                    010501
1.5.1.1                STRUCTURAL SYSTEM              01050101
1.5.1.1.1              PROPELLANT TANKS               0105010101
1.5.1.1.2              MAIN SHELL                     0105010102
1.5.1.2                AVIONICS SYSTEM                01050102
1.5.1.2.1              ELECTRICAL POWER               0105010201
1.5.1.2.2              INTEGRATION                    0105010202
1.5.2                  PROJECT MANAGEMENT             010502
1.5.2.1                COST CONTROL MANAGEMENT        01050201
1.5.2.2                CONFIGURATION MANAGEMENT       01050202
@PMD.EL
@FREE             PACE7A
@FREE             PACE7B
@FREE             PACE7C
@SYM              PACE7A
```

WBS Base Data Cards & Header Cards

Dollar Escalation Cards

Contractor Fee Card

WBS Title Cards

```
@SYM        PACE7B
@SYM        PACE7C
@XQT        SYS$*MSFC$.ZEROFL
PACE1B
@XQT        SYS$*MSFC$.ZEROFL
PACE1C
@XQT        SYS$*MSFC$.ZEROFL
PACE1D
@XQT        SYS$*MSFC$.ZEROFL
PACE1E
@XQT        SYS$*MSFC$.ZEROFL
PACE1F
@XQT        SYS$*MSFC$.ZEROFL
PACE1G
@XQT        SYS$*MSFC$.ZEROFL
PACE2A
@XQT        SYS$*MSFC$.ZEROFL
PACE2B
@XQT        SYS$*MSFC$.ZEROFL
PACE2C
@XQT        SYS$*MSFC$.ZEROFL
PACE3A
@XQT        SYS$*MSFC$.ZEROFL
PACE3B
@XQT        SYS$*MSFC$.ZEROFL
PACE3C
@XQT        SYS$*MSFC$.ZEROFL
PACE3D
@XQT        SYS$*MSFC$.ZEROFL
PACE4A
@XQT        SYS$*MSFC$.ZEROFL
PACE4B
@XQT        SYS$*MSFC$.ZEROFL
PACE4C
@XQT        SYS$*MSFC$.ZEROFL
PACE5A
@XQT        SYS$*MSFC$.ZEROFL
PACE6B
@XQT        SYS$*MSFC$.ZEROFL
PACE7A
@XQT        SYS$*MSFC$.ZEROFL
PACE7B
@XQT        SYS$*MSFC$.ZEROFL
PACE7C
@XQT        SYS$*MSFC$.CHECKFL
PACE1B
@XQT        SYS$*MSFC$.CHECKFL
PACE1C
@XQT        SYS$*MSFC$.CHECKFL
PACE1D
@XQT        SYS$*MSFC$.CHECKFL
PACE1E
@XQT        SYS$*MSFC$.CHECKFL
PACE1F
@XQT        SYS$*MSFC$.CHECKFL
PACE1G
@XQT        SYS$*MSFC$.CHECKFL
PACE2A
@XQT        SYS$*MSFC$.CHECKFL
PACE2B
```

```
@XQT            SYS$*MSFC$.CHECKFL
PACE2C
@XQT            SYS$*MSFC$.CHECKFL
PACE3A
@XQT            SYS$*MSFC$.CHECKFL
PACE3B
@XQT            SYS$*MSFC$.CHECKFL
PACE3C
@XQT            SYS$*MSFC$.CHECKFL
PACE3D
@XQT            SYS$*MSFC$.CHECKFL
PACE4A
@XQT            SYS$*MSFC$.CHECKFL
PACE4B
@XQT            SYS$*MSFC$.CHECKFL
PACE4C
@XQT            SYS$*MSFC$.CHECKFL
PACE5A
@XQT            SYS$*MSFC$.CHECKFL
PACE6B
@XQT            SYS$*MSFC$.CHECKFL
PACE7A
@XQT            SYS$*MSFC$.CHECKFL
PACE7B
@XQT            SYS$*MSFC$.CHECKFL
PACE7C
@DELETE,C       PACE1B
@DELETE,C       PACE1C
@DELETE,C       PACE1D
@DELETE,C       PACE1E
@DELETE,C       PACE1F
@DELETE,C       PACE1G
@DELETE,C       PACE2A
@DELETE,C       PACE2B
@DELETE,C       PACE2C
@DELETE,C       PACE3A
@DELETE,C       PACE3B
@DELETE,C       PACE3C
@DELETE,C       PACE3D
@DELETE,C       PACE4A
@DELETE,C       PACE4B
@DELETE,C       PACE4C
@DELETE,C       PACE5A
@DELETE,C       PACE6B
@DELETE,C       PACE7A
@DELETE,C       PACE7B
@DELETE,C       PACE7C
@FIN
@FIN
```

APPENDIX J

ERROR CODE LIST

Instructions for Correcting WBS Base Data Input Errors

ER-01 INVALID TRANSACTION TYPE

Cause: Transaction code not equal "B", "C", or "D".
Correction: Resubmit with correct code.

ER-02 INVALID MANPOWER RATE

Cause: Manpower rate not equal "H", "M", or "Y".
Correction: Resubmit with correct rate.

ER-03 INVALID FISCAL YEAR

Cause: Fiscal year not numeric or equal to zeros.
Correction: Resubmit with correct fiscal year.

ER-04 INVALID WBS

Cause: Work breakdown structure not numeric or equal to zeros.
Correction: Resubmit with correct work breakdown structure.

ER-08 TX COST ELEMENT NOT NUMERIC

Cause: Cost element contains letters, spaces, etc.
Correction: Resubmit with correct cost element.

ER-11 COLUMN 80 MUST CONTAIN "R" OR "N"

Cause: Incorrect character in column 80.
Correction: Resubmit with correct code in column 80.

NOTE: If any of the above errors occur, the transaction will not have been processed.

APPENDIX K

DESIGN-TO-COST REPORTS

DATE 27 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 0.92

FY W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
0105000000000000	72988	80454	45614	45998	25763	18490	354200	35650	21252
7601050000000000000	9149	11020	6900	6270	1104	1060	51980	15180	4600
7701050000000000000	26540	28105	23663	16518	10249	3543	161920	8280	9890
7801050000000000000	16672	18751	8142	11325	7055	3903	115920	5750	4600
7901050000000000000	20627	22578	6909	11885	7355	9984	24380	6440	2162

DATE 27 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 0.92

FY	W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
	0105010000000000	56973	63253	45614	32243	25763	11506	340860	16330	21252
	7601050!0000000000	4600	8280	6900	1840	1104		46000	5520	4600
	7701050100000000000	23240	24656	23663	12769	10249	2493	154560	5520	9890
	7801050100000000000	13069	13645	8142	8472	7055	1200	115920	2990	4600
	7901050100000000000	16069	16672	6909	9162	7355	7813	24380	2300	2162

DATE 27 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 0.92

FY	W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
01	05010100000000	30385	37898	28658	16161	15225	4293	312800	16330	21252
76	01050101000000000	4600	8280	6900	1840	1104		46000	5520	4600
77	01050101000000000	10470	17756	13653	6366	7066	690	138000	5520	9890
78	01050101000000000	5249	3599	4499	3449	3449	1200	110400	2990	4600
79	01050101000000000	10066	8263	3606	4506	3606	2403	18400	2300	2162

DATE 27 APR 76 MANPOWER SUMMARY IN MANHOURS DESIGN-TO-COST FACTOR = 0.92

FY	W B S	ENG	MFG	TLG	Q+RA	TEST	OTHER	MATRL-$	TRAVEL-$	OTH DIR-$
	0105010101000000	23175	27232	20695	11205	8615	3693	179400	15640	18170
76	0105010101000000	4600	8280	6900	1840	1104		46000	5520	4600
77	0105010101000000	5060	8740	6440	2760	1656	690	46000	5520	7360
78	0105010101000000	4499	2999	3749	2999	2249	1200	78200	2300	4600
79	0105010101000000	9016	7213	3606	3606	3606	1803	9200	2300	1610

DATE 05 MAY 76 — PROJECT=ABC PROJECT — DESIGN-TO-COST FACTOR = 0.92

WBS 1.5 — TITLE=ABC PROJECT — RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY = 76	FY = 77	FY = 78	FY = 79	FY =	FY =	FY =	FY =	TOTAL
ENGR.	HOURS	9,149	26,540	16,672	20,627					72,988
	LABOR/OH $	106,284	343,162	226,356	293,997					969,799
MFG	HOURS	11,020	29,105	18,751	22,578					80,454
	LABOR/OH $	100,602	308,874	216,555	274,029					900,060
TOOLING	HOURS	6,900	23,663	8,142	6,909					45,614
	LABOR/OH $	62,583	266,090	96,181	85,748					510,602
Q + RA	HOURS	6,270	16,518	11,325	11,885					45,998
	LABOR/OH $	64,487	206,624	148,765	164,037					583,913
TEST	HOURS	1,104	10,249	7,055	7,355					25,763
	LABOR/OH $	11,442	115,957	83,828	91,717					302,944
OTHER	HOURS	1,060	3,543	3,903	9,984					18,490
	LABOR/OH $	11,878	45,396	52,495	140,924					250,693
TOT LBR	HOURS	35,503	108,618	65,848	79,338					289,307
	LABOR/OH $	357,276	1,286,103	824,180	1,050,452					3,518,011
MATERIAL + SUBCON.		51,980	161,920	115,920	24,380					354,200
MATERIAL OVERHEAD		4,158	12,954	9,274	1,950					28,336
TRAVEL		15,180	8,280	5,750	6,440					35,650
OTHER		4,600	9,890	4,600	2,162					21,252
SUBTOTAL EST. COST		433,194	1,479,147	959,724	1,085,384					3,957,449
G + A EXPENSE		47,651	162,706	105,570	119,392					435,319
TOTAL EST. COST		480,845	1,641,853	1,065,294	1,204,776					4,392,768
FEE										
GRAND TOTAL		480,845	1,641,853	1,065,294	1,204,776					4,392,768

ESCALATION RATES

MATERIAL + SUBCON.	.000	.000	.000	.000
TRAVEL	.000	.000	.000	.000
OTHER	.000	.000	.000	.000

DATE 05 MAY 76 PROJECT=ABC PROJECT DESIGN-TO-COST FACTOR = 0.92

WBS 1.5.1 TITLE=ABC VEHICLE RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	4,600	23,240	13,069	16,064					56,973
	LABOR/OH $	53,438	330,493	177,438	228,960					760,329
MFG	HOURS	8,280	24,656	13,645	16,672					63,253
	LABOR/OH $	75,588	270,969	157,586	202,348					706,491
TOOLING	HOURS	6,900	23,663	8,142	6,909					45,614
	LABOR/OH $	62,583	266,090	96,181	85,748					510,602
Q + RA	HOURS	1,840	12,769	8,472	9,162					32,243
	LABOR/OH $	18,924	159,727	111,288	126,454					416,393
TEST	HOURS	1,104	10,249	7,055	7,355					25,763
	LABOR/OH $	11,442	115,957	83,828	91,717					302,944
OTHER	HOURS		2,493	1,200	7,813					11,506
	LABOR/OH $		31,943	16,140	110,280					158,363
TOT LBR	HOURS	22,724	97,070	51,583	63,975					235,352
	LABOR/OH $	221,975	1,145,179	642,461	845,507					2,855,122
MATERIAL + SUBCON.		46,000	154,560	115,920	24,380					340,860
MATERIAL OVERHEAD		3,680	12,365	9,274	1,950					27,269
TRAVEL		5,520	5,520	2,990	2,300					16,330
OTHER		4,600	9,890	4,600	2,162					21,252
SUBTOTAL EST. COST		281,775	1,327,514	775,245	876,299					3,260,833
G + A EXPENSE		30,995	146,027	85,277	96,393					358,692
TOTAL EST. COST		312,770	1,473,541	860,522	972,692					3,619,525

DATE 05 MAY 76 PROJECT=ABC PROJECT DESIGN-TO-COST FACTOR = 0.92

WBS 1.5.1.1 TITLE=STRUCTURAL SYSTEM RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY = 76	FY = 77	FY = 78	FY = 79	FY =	FY =	FY =	FY =	TOTAL
ENGR.	HOURS	4,600	10,470	5,249	10,066					30,385
	LABOR/OH $	53,438	135,377	71,266	143,471					403,552
MFG	HOURS	8,280	17,756	3,599	8,263					37,898
	LABOR/OH $	75,588	195,138	41,565	100,288					412,579
TOOLING	HOURS	6,900	13,653	4,499	3,606					28,658
	LABOR/OH $	62,583	153,528	53,147	44,754					314,012
Q + RA	HOURS	1,840	6,366	3,449	4,506					16,161
	LABOR/OH $	18,924	79,632	45,306	62,192					206,054
TEST	HOURS	1,104	7,066	3,449	3,606					15,225
	LABOR/OH $	11,442	79,945	40,981	44,967					177,335
OTHER	HOURS		690	1,200	2,403					4,293
	LABOR/OH $		8,841	16,140	33,918					58,899
TOT LBR.	HOURS	22,724	56,001	21,445	32,450					132,620
	LABOR/OH $	221,975	652,461	268,405	429,590					1,572,431
MATERIAL + SUBCON.		46,000	138,000	110,400	18,400					312,800
MATERIAL OVERHEAD		3,680	11,040	8,832	1,472					25,024
TRAVEL		5,520	5,520	2,990	2,300					16,330
OTHER		4,600	9,890	4,600	2,162					21,252
SUBTOTAL EST. COST		281,775	816,911	395,227	453,924					1,947,837
G + A EXPENSE		30,995	89,860	43,475	49,932					214,262
TOTAL EST. COST		312,770	906,771	438,702	503,856					2,162,099

DATE 05 MAY 76 PROJECT-ABC PROJECT DESIGN-TO-COST FACTOR = 0.92

WBS 1.5.1.1.1 TITLE-PROPELLANT TANKS RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	4,600	5,060	4,499	9,016					23,175
	LABOR/OH $	53,438	65,426	61,083	128,505					308,452
MFG	HOURS	8,280	8,740	2,999	7,213					27,232
	LABOR/OH $	75,588	96,053	34,635	87,544					293,820
TOOLING	HOURS	6,900	6,940	3,749	3,606					20,695
	LABOR/OH $	62,583	72,918	44,287	44,754					224,042
Q + RA	HOURS	1,840	2,760	2,999	3,606					11,205
	LABOR/OH $	18,924	34,525	39,395	49,770					142,614
TEST	HOURS	1,104	1,656	2,249	3,606					8,615
	LABOR/OH $	11,442	18,736	26,723	44,967					101,868
OTHER	HOURS		690	1,200	1,803					3,693
	LABOR/OH $		8,841	16,140	25,449					50,430
TOT LBR	HOURS	22,724	25,346	17,695	28,850					94,615
	LABOR/OH $	221,975	295,999	222,263	380,989					1,121,226
MATERIAL + SUBCON.		46,600	46,000	78,200	9,200					179,400
MATERIAL OVERHEAD		3,680	3,680	6,256	736					14,352
TRAVEL		5,520	5,520	2,300	2,300					15,640
OTHER		4,600	7,360	4,600	1,610					18,170
SUBTOTAL EST. COST		281,775	358,559	313,619	394,835					1,348,788
G + A EXPENSE		30,995	39,441	34,498	43,432					148,366
TOTAL EST. COST		312,770	398,000	348,117	438,267					1,497,154

APPENDIX L

RECURRING AND NONRECURRING COST REPORTS

DATE 04 MAY 76 | PROJECT=ABC PROJECT | DESIGN-TO-COST FACTOR = 1.00

WBS 1.6 | TITLE=ABC PROJECT | RECURRING COSTS ONLY

ELEMENTS OF COST		FY - 76	FY - 78	FY - 79	FY -	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	9,945	11,275	12,901						34,121
	LABOR/OH $	115,531	153,081	183,878						452,490
MFG	HOURS	11,978	15,492	12,901						40,371
	LABOR/OH $	109,347	178,917	156,579						444,843
TOOLING	HOURS	7,500	4,775	3,920						16,195
	LABOR/OH $	68,025	56,407	48,651						173,083
Q & RA	HOURS	6,816	7,909	6,858						21,582
	LABOR/OH $	70,092	103,893	94,654						268,639
TEST	HOURS	1,200	5,224	3,920						10,344
	LABOR/OH $	12,437	62,072	48,882						123,391
OTHER	HOURS	1,152	1,960	4,572						7,684
	LABOR/OH $	12,909	26,362	64,534						103,805
TOT LBR	HOURS	38,590	46,635	45,072						130,297
	LABOR/OH $	388,341	580,732	597,178						1,566,251
MATERIAL & SUBCON.		56,500	41,000	20,000						117,500
MATERIAL OVERHEAD		4,520	3,280	1,600						9,400
TRAVEL		16,500	1,750	4,500						22,750
OTHER		6,000		2,350						7,350
SUBTOTAL EST. COST		470,861	626,762	625,628						1,723,251
G & A EXPENSE		51,795	68,944	68,819						189,558
TOTAL EST. COST		522,656	695,706	694,447						1,912,809

DATE 04 MAY 76 PROJECT-ABC PROJECT DESIGN-TO-COST FACTOR = 1.00

WBS 1.5 TITLE-ABC PROJECT NONRECURRING COSTS ONLY

ELEMENTS OF COST		FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	28,846	6,846	9,520						45,212
	LABOR/OH $	372,979	92,948	135,689						601,616
MFG	HOURS	30,549	4,890	11,640						47,079
	LABOR/OH $	335,734	56,475	141,275						533,484
TOOLING	HOURS	25,720	4,275	3,590						33,385
	LABOR/OH $	289,221	48,138	44,555						381,914
Q + RA	HOURS	17,955	4,421	6,061						28,417
	LABOR/OH $	224,599	57,812	83,654						366,065
TEST	HOURS	11,140	2,445	4,075						17,660
	LABOR/OH $	126,038	29,051	50,815						205,904
OTHER	HOURS	3,851	2,282	6,280						12,413
	LABOR/OH $	49,343	30,693	88,642						168,678
TOT LBR	HOURS	118,061	24,939	41,166						184,166
	LABOR/OH $	1,397,914	315,117	544,630						2,257,661
MATERIAL + SUBCON.		176,000	85,000	6,500						267,500
MATERIAL OVERHEAD		14,080	6,800	520						21,400
TRAVEL		9,000	4,500	2,500						16,000
OTHER		10,750	5,000							15,750
SUBTOTAL EST. COST		1,607,744	416,417	554,150						2,578,311
G + A EXPENSE		176,852	45,806	60,957						283,615
TOTAL EST. COST		1,784,596	462,223	615,107						2,861,926

DATE 04 MAY 76 | PROJECT-ABC PROJECT | DESIGN-TO-COST FACTOR = 1.00

WBS 1.5 | TITLE-ABC PROJECT | RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	9,945	28,846	18,121	22,421					79,333
	LABOR/OH $	115,531	372,979	246,029	319,567					1,054,106
MFG	HOURS	11,978	30,549	20,382	24,541					87,450
	LABOR/OH $	109,347	335,734	235,392	297,854					978,327
TOOLING	HOURS	7,500	25,720	8,850	7,510					49,580
	LABOR/OH $	68,025	289,721	104,545	93,207					554,998
Q + RA	HOURS	6,815	17,955	12,310	12,919					49,999
	LABOR/OH $	70,092	224,599	161,704	178,308					634,703
TEST	HOURS	1,200	11,140	7,669	7,995					28,004
	LABOR/OH $	12,437	126,038	91,123	99,698					329,296
OTHER	HOURS	1,152	3,851	4,242	10,852					20,097
	LABOR/OH $	12,909	49,343	57,055	153,176					272,483
TOT LBR	HOURS	38,590	118,061	71,574	86,238					314,463
	LABOR/OH $	388,341	1,397,914	895,848	1,141,810					3,823,913
MATERIAL + SUBCON.		56,500	176,000	126,000	26,500					385,000
MATERIAL OVERHEAD		4,520	14,080	10,080	2,120					30,800
TRAVEL		16,500	9,000	6,250	7,000					38,750
OTHER		5,000	10,750	5,000	2,350					23,100
SUBTOTAL EST. COST		470,861	1,607,744	1,043,178	1,179,780					4,301,563
G + A EXPENSE		51,795	176,852	114,750	129,776					473,173
TOTAL EST. COST		522,656	1,784,596	1,157,928	1,309,556					4,774,736
FEE										
GRAND TOTAL		522,656	1,784,596	1,157,928	1,309,556					4,774,736

ESCALATION RATES

MATERIAL + SUBCON.	.000	.000	.000	.000
TRAVEL	.000	.000	.000	.000
OTHER	.000	.000	.000	.000

APPENDIX M

CONTRACTOR FEE REPORT

DATE 05 MAY 76 | PROJECT-ABC PROJECT | DESIGN-TO-COST FACTOR = 1.00

WBS 1.5 | TITLE-ABC PROJECT | RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	9,945	28,846	18,121	22,421					79,333
	LABOR/OH $	115,531	372,979	246,029	319,567					1,054,106
MFG	HOURS	11,978	30,549	20,382	24,541					87,450
	LABOR/OH $	109,347	335,734	235,392	297,854					978,327
TOOLING	HOURS	7,500	25,720	8,850	7,510					49,580
	LABOR/OH $	68,025	289,221	104,545	93,207					554,998
Q + RA	HOURS	6,815	17,955	12,310	12,919					49,999
	LABOR/OH $	70,092	224,599	161,704	178,308					634,703
TEST	HOURS	1,200	11,140	7,669	7,995					28,004
	LABOR/OH $	12,437	126,038	91,123	99,698					329,296
OTHER	HOURS	1,152	3,851	4,242	10,852					20,097
	LABOR/OH $	12,909	49,343	57,055	153,176					272,483
TOT LBR	HOURS	38,590	118,061	71,574	86,238					314,463
	LABOR/OH $	388,341	1,397,914	895,848	1,141,810					3,823,913
MATERIAL + SUBCON.		56,500	176,000	126,000	26,500					385,000
MATERIAL OVERHEAD		4,520	14,080	10,080	2,120					30,800
TRAVEL		16,500	9,000	6,250	7,000					38,750
OTHER		5,000	10,750	5,000	2,350					23,100
SUBTOTAL EST. COST		470,861	1,607,744	1,043,178	1,179,780					4,301,563
G + A EXPENSE		51,795	176,852	114,750	129,776					473,173
TOTAL EST. COST		522,656	1,784,596	1,157,928	1,309,556					4,774,736
FEE		41,812	142,767	92,634	104,764					381,977
GRAND TOTAL		564,468	1,927,363	1,250,562	1,414,320					5,156,713

ESCALATION RATES

MATERIAL + SUBCON.		.000	.000	.000	.000					
TRAVEL		.000	.000	.000	.000					
OTHER		.000	.000	.000	.000					

APPENDIX N

DOLLAR ESCALATION REPORT

DATE 04 MAY 76 — PROJECT-ABC PROJECT — DESIGN-TO-COST FACTOR = 1.00

WBS 1.5 — TITLE-ABC PROJECT — RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY =	FY =	FY =	FY =	TOTAL
ENGR.	HOURS	9,945	28,845	18,121	22,421					79,333
	LABOR/OH $	115,531	372,979	246,029	319,567					1,054,106
MFG	HOURS	11,978	30,549	20,382	24,541					87,450
	LABOR/OH $	109,347	335,734	235,392	297,854					978,327
TOOLING	HOURS	7,500	25,720	8,850	7,510					49,580
	LABOR/OH $	68,025	289,221	104,545	93,207					554,998
Q + RA	HOURS	6,815	17,955	12,310	12,919					49,999
	LABOR/OH $	70,092	224,599	161,704	178,308					634,703
TEST	HOURS	1,200	11,140	7,669	7,995					28,004
	LABOR/OH $	12,437	126,038	91,123	99,698					329,296
OTHER	HOURS	1,152	3,851	4,242	10,852					20,097
	LABOR/OH $	12,909	49,343	57,055	153,176					272,483
TOT LAB	HOURS	38,590	118,061	71,574	86,238					314,463
	LABOR/OH $	388,341	1,397,914	895,848	1,141,810					3,823,913
MATERIAL + SUBCON.		57,687	183,392	134,442	28,965					404,486
MATERIAL OVERHEAD		4,615	14,671	10,755	2,317					32,358
TRAVEL		16,830	9,360	6,625	7,560					40,375
OTHER		5,100	11,234	5,375	2,597					24,306
SUBTOTAL EST. COST		472,573	1,616,571	1,053,045	1,183,249					4,325,438
G + A EXPENSE		51,983	177,823	115,835	130,157					475,798
TOTAL EST. COST		524,556	1,794,394	1,168,880	1,313,406					4,801,236
FEE										
GRAND TOTAL		524,556	1,794,394	1,168,880	1,313,406					4,801,236

ESCALATION RATES

MATERIAL + SUBCON.		.021	.021	.025	.026					
TRAVEL		.020	.020	.020	.020					
OTHER		.020	.025	.030	.030					

DATE 04 MAY 76 PROJECT-ABC PROJECT DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.1 TITLE-ABC VEHICLE RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	5,000	25,260	14,205	17,461					61,926
	LABOR/OH $	58,085	326,612	192,861	248,872					826,430
MFG	HOURS	9,000	26,800	14,832	18,121					68,753
	LABOR/OH $	82,161	294,532	171,295	219,935					767,923
TOOLING	HOURS	7,500	25,720	8,850	7,510					49,580
	LABOR/OH $	68,025	289,221	104,545	93,207					554,998
Q + RA	HOURS	2,000	13,880	9,209	9,959					35,048
	LABOR/OH $	20,570	173,625	120,969	137,454					452,618
TEST	HOURS	1,200	11,140	7,669	7,995					28,004
	LABOR/OH $	12,437	126,038	91,123	99,698					329,296
OTHER	HOURS		2,710	1,304	8,492					12,506
	LABOR/OH $		34,723	17,539	119,865					172,127
TOT LAB	HOURS	24,700	105,510	56,069	69,538					255,817
	LABOR/OH $	241,278	1,244,751	698,332	919,031					3,103,392
MATERIAL + SUBCON.		51,050	175,056	134,442	28,965					389,513
MATERIAL OVERHEAD		4,084	14,004	10,755	2,317					31,160
TRAVEL		6,120	6,240	3,445	2,700					18,505
OTHER		5,100	11,234	5,375	2,597					24,306
SUBTOTAL EST. COST		307,632	1,151,285	852,349	955,610					3,566,876
G + A EXPENSE		33,840	159,641	93,758	105,117					392,356
TOTAL EST. COST		341,472	1,610,926	946,107	1,060,727					3,959,232

DATE 04 MAY 76 PROJECT-ABC PROJECT DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.1.1 TITLE-STRUCTURAL SYSTEM RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	5,000	11,380	5,705	10,941					33,026
	LABOR/OH $	58,085	147,143	77,457	155,942					438,627
MFG	HOURS	9,000	19,300	3,912	8,981					41,193
	LABOR/OH $	82,161	212,107	45,180	109,002					448,450
TOOLING	HOURS	7,500	14,840	4,890	3,920					31,150
	LABOR/OH $	68,025	166,876	57,766	48,651					341,318
Q + RA	HOURS	2,000	6,920	3,749	4,898					17,567
	LABOR/OH $	20,570	86,562	49,247	67,602					223,981
TEST	HOURS	1,200	7,680	3,749	3,920					16,549
	LABOR/OH $	12,437	86,892	44,546	48,882					192,757
OTHER	HOURS		750	1,304	2,612					4,666
	LABOR/OH $		9,610	17,539	36,868					64,017
TOT LBR	HOURS	24,700	60,870	23,309	35,272					144,151
	LABOR/OH $	241,278	709,190	291,735	466,947					1,709,150
MATERIAL + SUBCON.		51,050	156,300	128,040	21,860					357,250
MATERIAL OVERHEAD		4,084	12,504	10,243	1,749					28,580
TRAVEL		6,120	6,240	3,445	2,700					18,505
OTHER		5,100	11,234	5,375	2,597					24,306
SUBTOTAL EST. COST		307,632	895,468	438,838	495,853					2,137,791
G + A EXPENSE		33,840	98,501	48,272	54,544					235,157
TOTAL EST. COST		341,472	993,969	487,110	550,397					2,372,948

DATE 04 MAY 76 PROJECT-ABC PROJECT DESIGN-TO-COST FACTOR = 1.00

WBS 1.5.1.1.1 TITLE-PROPELLANT TANKS RECURRING & NONRECURRING COSTS

ELEMENTS OF COST		FY - 76	FY - 77	FY - 78	FY - 79	FY -	FY -	FY -	FY -	TOTAL
ENGR.	HOURS	5,000	5,500	4,890	9,800					25,190
	LABOR/OH $	58,085	71,115	66,392	139,679					335,271
MFG	HOURS	9,000	9,500	3,260	7,840					29,600
	LABOR/OH $	82,161	104,405	37,650	95,154					319,370
TOOLING	HOURS	7,500	7,000	4,075	3,920					22,495
	LABOR/OH $	68,025	78,715	48,138	48,651					243,529
Q + RA	HOURS	2,000	3,000	3,260	3,920					12,180
	LABOR/OH $	20,570	37,527	42,823	54,104					155,024
TEST	HOURS	1,200	1,800	2,445	3,920					9,365
	LABOR/OH $	12,437	20,365	29,051	48,882					110,735
OTHER	HOURS		750	1,304	1,960					4,014
	LABOR/OH $		9,610	17,539	27,665					54,814
TOT LBR	HOURS	24,700	27,550	19,234	31,360					102,844
	LABOR/OH $	241,278	321,737	241,593	414,135					1,218,743
MATERIAL + SUBCON.		51,050	52,100	90,695	10,930					204,775
MATERIAL OVERHEAD		4,084	4,168	7,256	874					16,382
TRAVEL		6,120	6,240	2,650	2,700					17,710
OTHER		5,100	8,360	5,375	1,934					20,769
SUBTOTAL EST. COST		307,632	392,605	347,569	430,573					1,478,379
G + A EXPENSE		33,840	43,187	38,233	47,363					162,623
TOTAL EST. COST		341,472	435,792	385,802	477,936					1,641,002

APPENDIX O

SENSITIVE RUN PROCEDURE

PROCEDURES FOR PROCESSING SENSITIVE SEB JOBS BY COMPUTER SERVICES OFFICE

PURPOSE:

The following paragraphs establish responsibilities, and outline procedures for punching of input data and receipt, scheduling of processing, control and disposition of computer jobs, program card decks, magnetic tapes and printed material which pertains to sensitive SEB data processed through the Computer Services Office.

INPUT PREPARATION:

Input data will be punched by requesting activity or scheduled to be punched by the Huntsville Computer Complex, AH01, keypunch section. The requesting activity will contact Mr. Clayton McGee, or Mr. John D. Gibbons, AH32, 453-4181, for establishment of priority and a definite "Start Time," if work is to be done by Huntsville Computer Complex. Unlabeled transmittals will be hand carried by a monitor from the requesting activity to the keypunch supervisor. The monitor will observe the keypunch operation until completion. Cards containing errors must be turned over to the monitor for disposition. At completion of the job, the monitor will carry back the erroneous cards, all transmittals, valid card decks, and/or tapes pertaining to his job.

SCHEDULING COMPUTER TIME:

Offices requiring sensitive computer runs must contact Mr. C. L. Cozelos, AH23, 453-3347, or Mr. J. T. Felder, AH21, 453-3341. An approximate "Start Time" will be agreed upon for starting the sensitive run.

DELIVERY TO COMPUTER:

The requester will be responsible for providing a monitor to deliver all necessary program decks/tapes, data, magnetic tapes, and any other material required for processing sensitive material to the input/output control desk (453-4478) at the south door of B-Wing, Building 4663, a minimum of 30 minutes before "Start Time."

COMPUTER PROCESSING:

All sensitive jobs must meet normal job submission requirements. The monitor, upon arrival at the control desk, will inform the control clerk that he has a sensitive run. The control clerk will not accept the job, but will immediately notify Dr. J. C. Morelock or Mr. Hurley Bedsole, AH23, 453-3349.

If Dr. Morelock and Mr. Bedsole are both unavailable, Mr. Cozelos will be contacted. Dr. Morelock, Mr. Bedsole, or an acceptable alternate will be responsible for necessary preparations of the computer area for processing of sensitive material and assure a minimum number of operators are on hand for processing of the job. The requesting monitor and the Operations Branch monitor will be responsible for remaining in the computer room during processing of the job and assure that all printouts are removed as they are printed.

If tapes other than a program tape are required, only unnumbered tape reels will be used for processing sensitive jobs. Upon completion of the job, a new label identifying the tapes as sensitive and reflecting a user reel number for future reference will be affixed to the tapes used during processing. All input, output, and tapes used will be given to the requesting monitor for disposition.

After tapes are no longer required by the requesting activity, they will be processed through a computer program which writes a character containing all bits in every position of the tape or the tape will be erased using the tape evaluator and will be returned to the CSO tape inventory.

In case of emergency program debugging during a production run of sensitive material, contact Mr. Peter Wright, 453-3344, or Mr. Phil Anderson, 453-3342, for assignment of a civil service programmer to perform the program checkout.

All reproduction of sensitive outputs will be the responsibility of the requesting activity.

Storage or transportation of sensitive information in any form will not be performed by computer operations contractor personnel.

JOHN C. LYNN
Director, Computer Services Office

APPROVAL

PACE

PRICING AND COST ESTIMATING HANDBOOK

Prepared by
Systems Analysis and Integration Laboratory
and
Computer Services Office

The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.

JOHN C. LYNN
Director, Computer Services Office

H. E. THOMASON
Director, Systems Analysis and Integration Laboratory

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